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RIGHT AT GRAND CENTRAL — FRANK J. CROHAN, President

The first of the year a circular letter was sent to members informing them that it seemed possible to have an employment clearing house at the association's headquarters and asking for their co-operation.

On behalf of the men who have since then found permanent positions through the medium of the NEW ENGLAND WATER WORKS ASSOCIATION and on behalf of those who will in the future, deep appreciation is hereby expressed to the firms and individuals who have already provided positions for men registered here and to those firms and individuals who have written to the headquarters of the association to give assurance of their co-operation.

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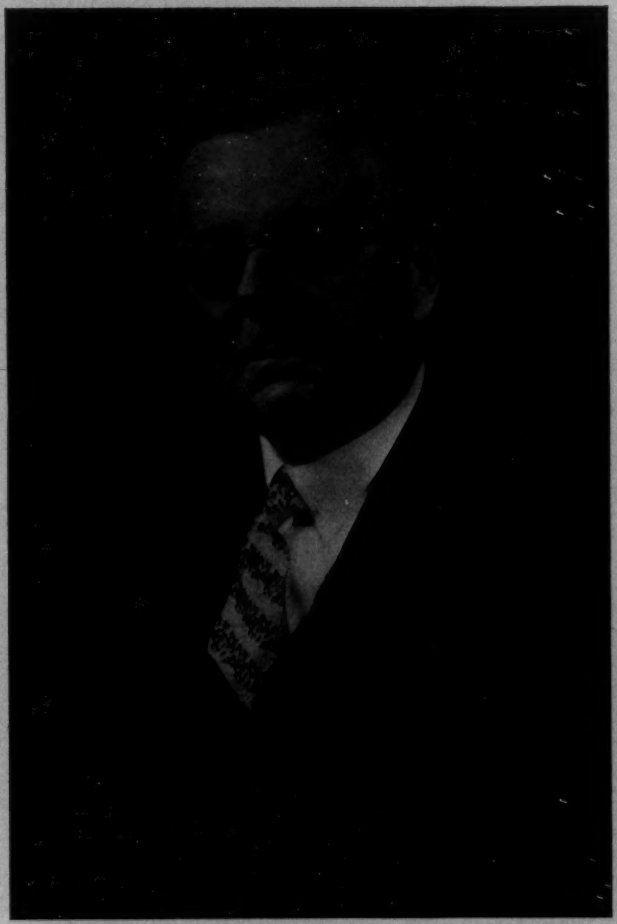

Photo by Bachrach

HOWARD M. KING

President of the New England Water Works Association

1934 - 1935

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EXPERIMENTAL STUDY OF POROUS PLATES FOR USE IN FILTER BOTTOMS FOR RAPID FILTERS.

THOMAS R. CAMP.*
[*Read September 19, 1934.*]

Modern mechanical or "rapid-sand" filters, zeolite beds and other water-treatment units comprising tanks holding filtering or contact media are now commonly designed so that the media may be washed by passing the wash water upward through the material at a sufficiently high velocity to suspend the grains in the rising water. The sediment collected in the filtering or contact material during operation is thus washed upward through the bed and out through wash gutters provided for that purpose (see Fig. 1). This method of wash requires upward velocities of wash water which are many times those obtaining in the filtration process, and, inasmuch as the underdrainage system must perform the function of distributing the wash water uniformly as well as that of collecting the filtered water, the hydraulic design of the underdrains is determined almost wholly by the washing function.

The aim in the design of an underdrainage system is to distribute the wash water to the under side of the bed in such a manner that each unit area of bed will receive substantially the same rate of washing. If this is done, short-circuiting or channeling of the wash water through the bed may be prevented and the whole bed will be evenly washed. In order to accomplish this result it is essential that friction losses be properly apportioned.

Conventional Filter Bottom. The conventional filter bottom (Fig. 1) consists of a manifold which distributes the wash water horizontally under the bed through laterals. The water is then carried vertically into the bed through orifices which are usually spaced uniformly over the bed area at intervals of from about 3 to 12 in. Inasmuch as each orifice discharges the wash water at a point, it is necessary to further disperse this water over the bed area assigned to the orifice before the water reaches the bed. This dispersion is usually accomplished by means of a layer of gravel or other coarse granular material surrounding and covering the manifold system. The layer of coarse material is usually about 12 to 18 in. deep and the grains are graded in size from coarse at the bottom to fine at the top. The uppermost grains which support the filter medium should be small enough to prevent

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the grains of the filter medium from penetrating into the coarse material, and they should be large enough to prevent their own displacement under the action of the rising wash water. The manifold system may consist of metal pipes or castings, of concrete channels or both. The orifices may be small round holes or tubes or they may be in the form of "strainer heads."

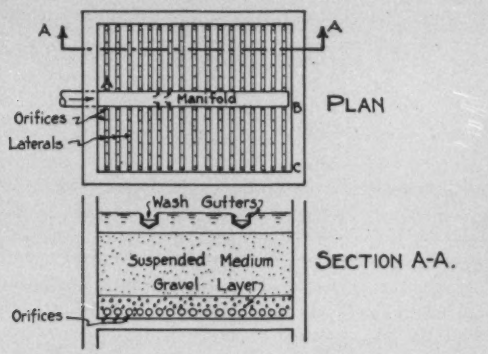

FIG. 1.— CONVENTIONAL RAPID-SAND FILTER.
(Showing Sand Expanded During Washing Process.)

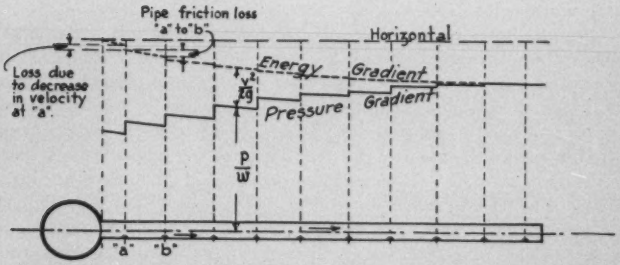

FIG. 2.— ENERGY AND PRESSURE GRADIENTS IN LATERAL.

The friction losses in washing through such a system will consist of the head losses through the manifold and laterals, the orifices, the gravel and the filter medium. It is obvious from Figure 1 that the drop in pressure due to pipe friction in the manifold and laterals will be greater at orifice C than at orifice A. On the other hand, if the laterals are of constant cross-section area, as is the usual case, the velocity along any lateral, as from B to C, will decrease due to the decrease in discharge as the water passes out through

the intervening orifices. This decrease in velocity and hence in velocity head will be accompanied by a corresponding increase in pressure head modified only by the head losses due to decrease in velocity. Hence the pressures in the lateral at B and C will be different, and the pressure at C may be either greater or less than that at B. It will be greater if the head loss between B and C is less than the velocity head in the pipe at B; and it will be less if the head loss exceeds the velocity head at B.

These principles may be better understood by recourse to Bernoulli's theorem, which is a statement of the energy content per unit weight of liquid at any point in a flowing stream. In Figure 2, the total energy head above the center of the lateral at any point is the sum of the pressure head $\left(\frac{p}{w}\right)$ which may be considered as potential energy head and the velocity head $\left(\frac{V^2}{2g}\right)$ or kinetic energy head. The friction losses are represented by the drop in the energy gradient from point to point. The losses due to friction along the lateral between orifices can be estimated, but very little is known about the magnitude of the losses due to decrease in velocity or sudden expansion of the liquid passing the orifices. For this reason the difference in pressure available at any two orifices, say A and C of Figure 1, cannot be estimated accurately.

The discharge through an orifice or strainer is proportional to the square root of the lost head, which is the difference in head available on the two sides of the pipe at the orifice. Inasmuch as the movement of water in the coarse gravel surrounding the orifices is very free, the pressure will be uniform at the exit side of the orifices at all points outside of the jets themselves. The energy head available for loss through the orifices will therefore vary among the orifices by only the difference in energy available in the pipes. The head available in a lateral for flow through an orifice is not the pressure head at the orifice as shown in Figure 2, however, as the velocity in the pipe past the orifice has some influence upon the flow through the orifice. J. E. Carson* has shown that for the same pressure head the discharge through an orifice is decreased with increase in pipe velocity.

Because of the difficulty of estimating accurately the variation in head available for flow through the orifices, it has become necessary in design to make the lost head through the orifices large in comparison with this variation in order to secure comparatively uniform flow through all the orifices. For example, if a rough estimate indicates a possible difference of head of 1.0 ft. available for flow at orifices A and C (Fig. 1), it will be necessary to induce a loss of 4 ft. through one of the orifices and a loss of 3 ft. through the other in order that the discharges may vary by not more than 13.5 per cent.† If the losses are made 12 and 11 ft. respectively, the discharges will vary by not more than 4.2 per cent. In practice the losses taken through the orifices vary among filter plants from about 4 to 12 ft.

*Jour. A. W. W. A., Aug. 1934, p. 1035. †Since the discharge varies as the square root of the loss.

In the design of conventional filter bottoms attention has been directed, as has just been indicated, toward securing as nearly as practicable the same discharge through all the orifices. It has evidently been assumed that uniform discharge from the orifices is necessary for uniform distribution of washing liquid to the bed. Such is not the case, however. The gravel layer is the final and effective medium for the distribution of wash water to the bed. As has been pointed out, the pressure is comparatively uniform within the coarse gravel surrounding the orifices because of the freedom of movement of the liquid in this portion of the filter. Also because of this freedom of movement, inequalities in discharge from the orifices will be equalized within the coarse gravel. The movement of water upward through the finer gravel just under the filter medium is not so free, however, and head losses occur here which are very great as compared to the losses through the coarse gravel surrounding the manifold system.

In experiments by Gilbert* under the direction of the author, the head loss was determined through an 18-in. layer of gravel with no sand bed above. Sixty per cent. of the stones were larger than ¾ in. and none were smaller than ¼ in. For a flow equivalent to a 24-in. wash-water rise per minute, the loss of head through the gravel was only 0.03 ft. Experiments by others for 18-in. gravel layers with sand beds above have indicated losses varying from about 0.3 to 0.9 ft. for the same rate of wash. These greater losses are doubtless due to the presence of finer material at the top of the gravel, down to 10-mesh, and the higher of these head losses are probably due to the presence of filter sand within the gravel layer. These observations warrant the conclusion, as brought out by Gilbert, that the loss of head in the gravel of a normal filter is nearly all concentrated in the finer material just under the sand. This finer gravel therefore constitutes a second wash water distribution system, and, unless graded so as to distribute the water evenly to the sand will completely offset the distribution efforts of the strainer or orifice system below.

The gravel layer in a conventional filter bottom performs three functions: to support the filtering material, to dissipate the high velocities of the jets, and, as has been shown, to distribute the wash water uniformly to the filter bed. Inasmuch as the gravel is the effective distributing agent, it follows that the orifice system may well be dispensed with in favor of an equalizing chamber under the gravel. Obviously a loose granular material such as gravel cannot be maintained in position above a chamber without some means of support through which the wash water can pass freely. Moreover, support from below is not enough to maintain the gravel in position. It is often carried upward and mixed with the sand during the washing process. This failure of the gravel to stay in position is one of the greatest sources of trouble in modern filter plants. It is so great a source of trouble that many efforts have been made to design systems which dispense with the gravel altogether. The gravel cannot be eliminated, however,

*Master's thesis, M. I. T., 1933.

unless it is replaced with some other porous medium capable of performing the functions of the gravel layer. A system of rigid porous plates constitutes such a porous medium. A system of porous plates may be substituted for both the gravel layer and its pervious means of support above the equalizing chamber, and it possesses the added advantage over the gravel in that it cannot be displaced from position in the washing process. A suggested design for a porous plate system is shown in Figure 3.

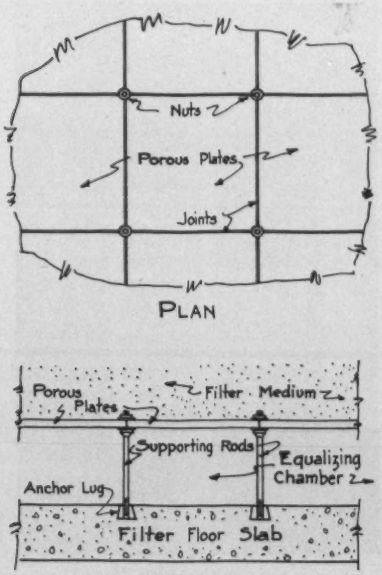

FIG. 3.— A POROUS PLATE FILTER BOTTOM.

Porous Plate Filter Bottom. A joint research program was started last winter by the Norton Company of Worcester and the author, having as its object the development of a practical porous plate filter bottom. Through the courtesy of the City of Providence, much of the experimental work has been carried on at the Scituate Water Treatment Plant of the Providence Water Works.

The first apparatus to be constructed consisted of a steel experimental filter unit having a filter area of two square feet and designed so that the

porous plates might be changed with facility (see Fig. 4). This unit was installed to take water directly from the main filter influent conduit or from the mixing basin or from both in any desired ratio. The settling basins of the Providence plant have a detention period of about four days which accomplishes a removal of about 90 per cent. of the floc as measured by iron content. Hence facilities for applying a mixture in any desired ratio of settled and unsettled water to the experimental filter make available waters

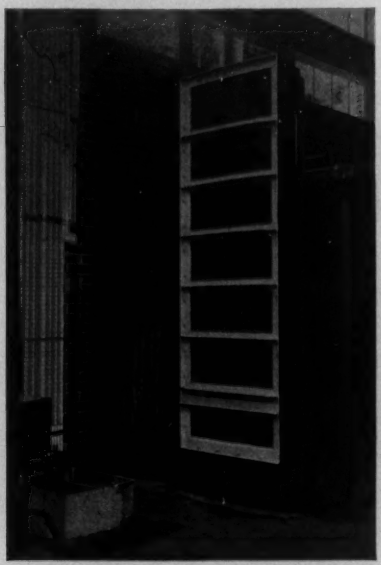

FIG. 4.— STEEL EXPERIMENTAL FILTER UNIT.

varying widely in character. Facilities are also available for passing clear water through the unit. The rate of filtration is controlled accurately at any rate up to about 5 g.p.m. per sq. ft. Washing can be done at any rate up to about 48 in. rise per minute and a manometer is provided for reading the rate of wash at any instant.

Piezometer connections are provided through the side-wall of the filter below and above the plates and at intervals of 3 and 6 in. throughout the depth of sand and above the top of the sand. These connections consist of copper tubes 2 ft. long which may be moved inward or outward during a wash so as to read the pressure at any desired distance into the bed from the filter wall. The outside ends of these copper tubes are connected by

rubber tubing to glass tubes mounted upon a board graduated to read feet of head. The wash water rate manometer is placed adjacent to this board so that during a wash both rate of wash and head loss may be obtained at any instant by photographing the board. The filter is provided with a plate glass front, so that the position of the top of the bed may be seen at any instant during washing, and the condition of the bed observed at any time during filtration.

The first experiments were conducted without the sand in place in order to determine the head loss through various types of plates for given

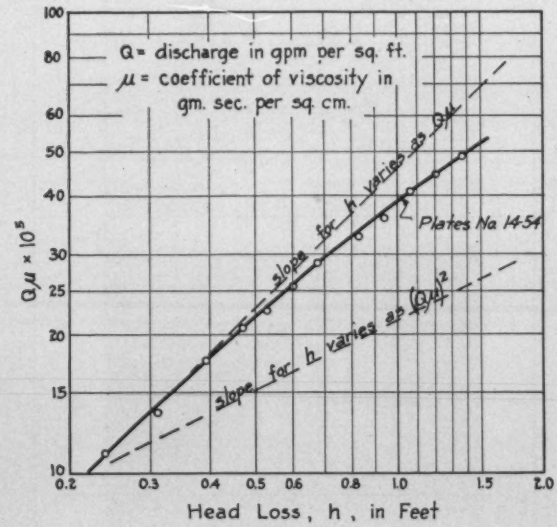

FIG. 5.— A TYPICAL CALIBRATION CURVE FOR POROUS PLATES.

wash rates. Inasmuch as porous plates are similar in texture to sand beds, the flow through such plates at normal velocities is streamline or viscous in character and the head loss should vary directly with the discharge. Such is not the case with perforated plates unless the passages are extremely small and very long in comparison with their diameters. Porous plates thus possess an advantage over both perforated plates and other orifice systems in that the rate of wash may be increased without an undue increase in head loss. For example, if it is desired to double the rate of wash which produces a head loss of 4 ft., the resulting head loss for porous plates would be 8 ft.; but for orifice systems it would be 16 ft. Figure 5 is a typical calibration curve of one of the porous plates. Since head loss is a function of viscosity

in streamline flow, ordinates are plotted as the product of discharge and viscosity. It will be noted that the calibration curve for this plate does not conform strictly to the streamline relation. This is due to the fact that some of the air present in the pores of the plate before submergence is trapped in the plate during submergence and remains there. The air, being compressi-

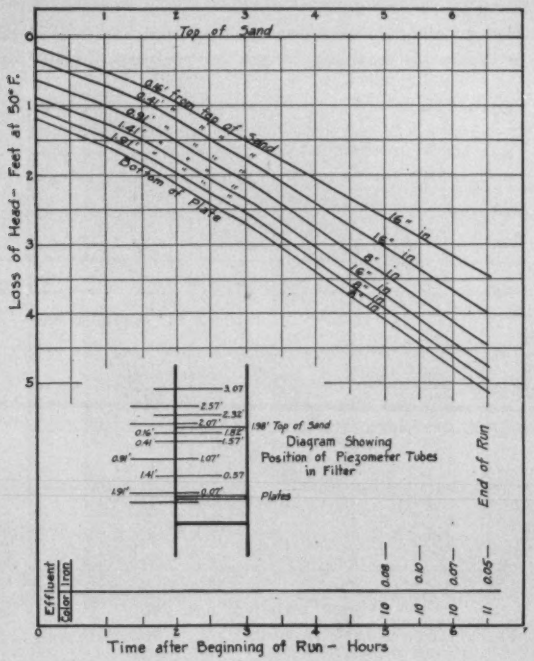

FIG. 6.— DATA FOR FILTER RUN NO. 7.
Sand=Cape Cod 23¾". Water Temp.=34.5° F. Rate=2.95 g.p.m./ft.²
Applied Water=67% Unsettled, 33% Settled; Iron 2.44 p.p.m.±
Sand Analysis=Effective Size 0.48 mm., Uniformity Coefficient 1.33.

ble, changes the shapes of some of the water passages as the rate of flow is changed. This discrepancy from true streamline flow is of little practical importance.

The next series of experiments was conducted with the sand in place with the object of determining the character of plate required for various kinds of sand, types of applied water and rates of filtration. Numerous filter runs were made followed by washing, in both of which operations all

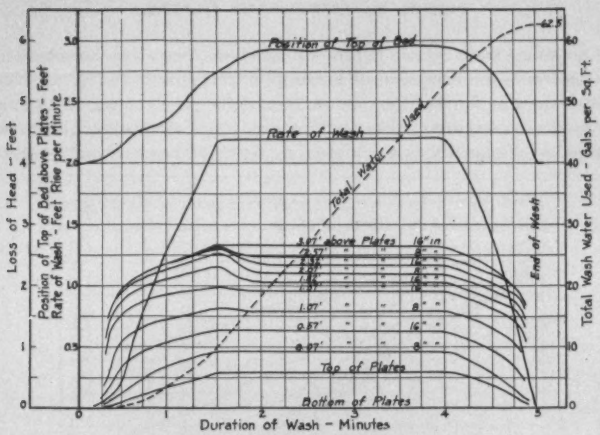
Loss of Head - Feet
Position of Top of Bed above Plates - Feet
Rate of Wash - Feet Rise per Minute.
Total Wash Water Used - Gals. per Sq. Ft.
Duration of Wash - Minutes
Position of Top of Bed
Rate of Wash
Total Water Used
End of Wash
3.01' above Plates 16" in
2.57' " " 16" "
2.13' " " 16" "
1.77' " " 16" "
1.37' " " 16" "
1.07' " " 8" "
0.87' " " 16" "
0.67' " " 8" "
Top of Plates
Bottom of Plates

FIG. 7.— DATA FOR FILTER WASH NO. 7.
Sand = Cape Cod 23¾". Water Temp. = 34.5° F.
Wash Water = 5.4% of Water Filtered.

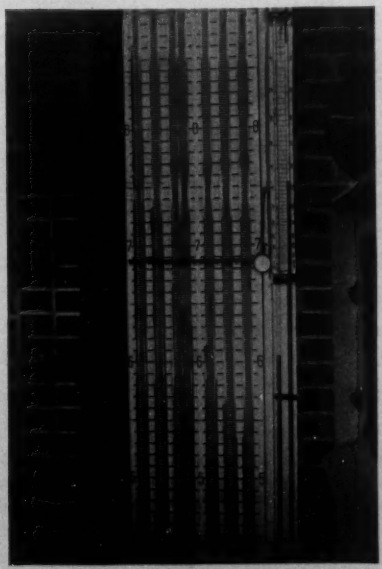

FIG. 8.— ONE OF 16 PHOTOGRAPHS OF MANOMETER BOARD TAKEN DURING A SINGLE WASHING OPERATION.

pertinent data were taken. Figure 6 shows head losses and the position of piezometers in the bed during Run No. 7 of this series. Ferric sulphate is used as the coagulant at Providence. Hence the iron content in the water was used as a measure of filter performance, with color and turbidity readings taken occasionally as rough checks. Figure 7 shows the data collected

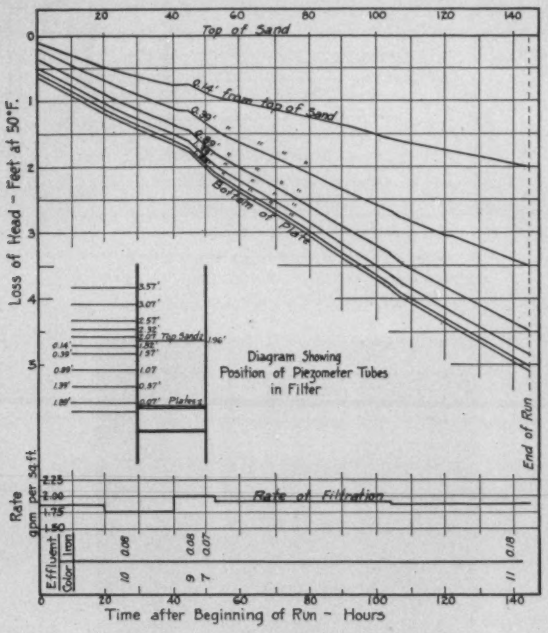

FIG. 9.— DATA FOR FILTER RUN NO. 9.
Sand=Cape Cod Screened 23½".
Water Temp.=35.7° F. Ave. Rate=1.88 g.p.m./ft.²
Applied Water=Color 18, Iron 0.40 p.p.m.
Sand Analysis=Effective Size 0.57 mm., Uniformity Coefficient 1.28.

during the wash following this run. Observations were made during the wash at intervals of 15 seconds and 30 seconds of rate of wash, loss of head through the plates and sand layers between piezometers, and the position of the top of the bed. The manometer board was read photographically. Figure 8 shows one exposure of the manometer board during a wash. Figure 9 is the record of Run No. 9 of this series and Figure 10 is the record of the wash following Run No. 9.

One of the prime questions to be settled concerning the use of porous plates for filter bottoms is that regarding the clogging of the plates. When used for diffusion of air in the activated-sludge process of sewage treatment, porous plates are subject to clogging and, unless every precaution is taken, the plates must be cleaned sooner or later. Inasmuch as the plates when used in a water filter are not intended to pass anything but filtered water it might be assumed that no clogging would occur if the filter is functioning properly. Our observations indicate, however, that even with the best of filter runs there is no such thing as 100 per cent. removal of filtrable matter. When an iron compound is used as a coagulant, iron determinations form an

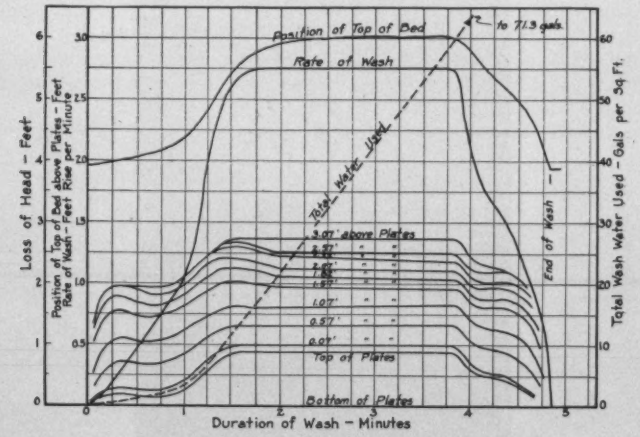

FIG. 10.— DATA FOR FILTER WASH NO. 9.
Sand = Cape Cod Screened 23½". Water Temp. = 35.2° F.
Wash Water = 0.44% of Water Filtered.

excellent basis for measuring filter performance. At Providence, the filtered water always contains from 0.02 to 0.06 p.p.m. of iron. If alum is used as a coagulant, alumina determinations should give an equally good measure of filter performance. The amount of iron or alumina appearing in the filtered water is, of course, influenced greatly by the adequacy of pretreatment or coagulation and settling. Some of the iron or alumina passing through a filter is in such a physical state that it is subject to removal by the plates, and when this is the case clogging may be expected. Some of the deposit will be washed out of the plates when the filter is washed, but since the plate is rigid the filter wash is not an effective means of cleaning the plates. The deposit within the plate is probably similar to the coating which accumulates upon the sand grains of the filter.

Studies of the clogging of the plates are still in progress and have as their object the determination of the expected rate of clogging of plates of different types when operating under different conditions. They also have to do with the determination of practical methods for cleaning the plates after they have become clogged.

In some of the experiments already completed, coagulated water was filtered through porous plates without passing through a sand bed in order

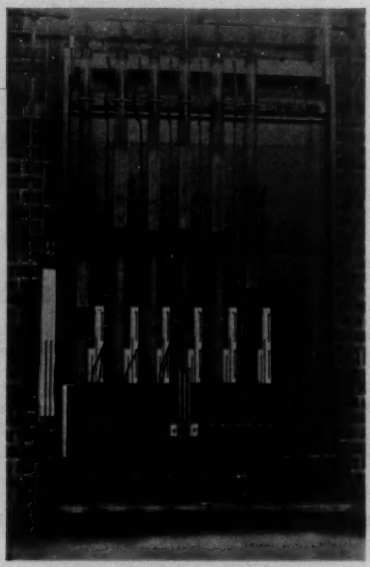

FIG. 11.— BATTERY OF TUBULAR EXPERIMENTAL FILTERS.

to build up rapidly the head loss through the plates. This was done so as to determine whether or not the clogging of the plates interfered with the uniformity of distribution of wash water. Plates were clogged to a head loss of 8 ft. at normal wash rates without showing any indication of poorer distribution of wash water. The clogging process both in the filter sand and the porous plates is an equalizing process. If one portion of the porous medium tends to clog before another portion in the same horizontal plane, some of the water and sediment formerly applied to the rapidly clogging portion is diverted to the more open portion thus equalizing the rate of clogging. Hence good distribution of wash water may be expected no matter

how much the plates have clogged, but the amount of clogging permissible will be limited by structural considerations and the head available.

In order to compare the rates of clogging of plates of different types and to make estimates of the life of plates between cleanings, a battery of six 2-in. glass tube filters was constructed. These filters were provided with castings at the bottom for holding porous plates (see Fig. 11). The plates were made up as disks. A mercury manometer was provided for each filter. During the run this is used for measuring loss of head through the filter and during the wash for measuring loss of head through the plate. This battery of filters has been in operation for about two months. The clogging is too slight as yet to warrant drawing any conclusions regarding the life of the plates between cleanings or the relative merits of the different types.

Many tests have been made upon the cleaning of the plates with various solutions, and other cleaning studies are still in progress. These studies are promising and indicate that practical methods of cleaning will be developed.

GAIN IN HEAD AT TAKE-OFFS.

BY W. E. HOWLAND.*

[*Received June 20, 1934.*]

When a stream of water divides into two streams, for example, when a leak occurs in a flowing pipe or when the flow divides in a smooth tee branch fitting, a rather surprising pressure change may often be observed. The water in the straight-flowing stream may experience an apparent gain in head,— not merely a gain in pressure head to correspond with the computed reduction in velocity head but an apparent gain in total head.

The sketch presented in Figure 1 may help to describe this effect. It illustrates the general case of the take-off, *i.e.*, the place where a side

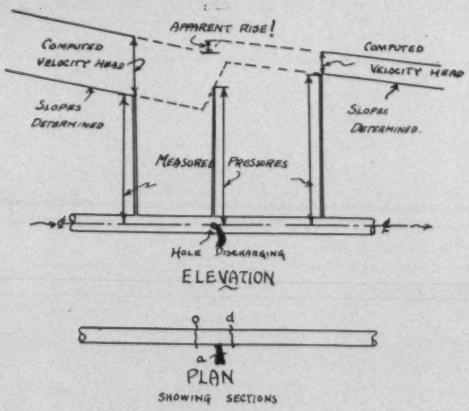

FIG. 1

Sketch of head relationships in a take-off.

stream separates from a straight-flowing main stream, whether we deal with an orifice or tube discharging water from the side of a pipe as in the case of the filter lateral supplying wash water to the base of a filter, or with a cross or tee branch fitting, in which the flows divide as shown. The sum of the pressure head and computed velocity heads at section (d), the down stream section on the main stream, is often larger than the corresponding sum of pressure and velocity heads at section (o), the upstream section. In other words, if the Bernoulli equation is written: total head at section (o) equals total head at section (d), the so-called head loss term that must be introduced on the right side of the equation in order to balance it will, in general,

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be found to be negative for ratios of side flow to main flow of less than 1 to 2.[1] In other words, a gain in head is observed. For certain take-offs such as screw fittings whose irregular interior surfaces, doubtless, promote great irregularity and turbulence of flow the head losses are generally positive as found by Giesecke.[2]

When there are a number of take-offs through side branches along a pipe, the cumulative effect of gain in head may be appreciable and may have to be taken into consideration in computations of pressure distribution along the pipe as already suggested by the author[3] and as actually determined by Professor Goodenough in his experiments on the model of the Holland tunnel.[4,5]

Keeping in mind that the velocity in a pipe is smallest near the wall and greatest near the center, one explanation of the gain in head at take-offs given by Peterman[1a]* is that the branch scoops off the relatively slow-moving edge layers of water, leaving the fast-moving and therefore high-energy containing central core of water to flow past the take-off. The result is that the water continuing past the take-off has a higher average unit energy content, or head, than the complete stream approaching the take-off. The methods of analysis thus far employed by different observers in representing experimental data on the effect of take-offs are not based upon such a rational view of the hydraulic phenomena involved and do not furnish results convenient for comparison.

In connection with certain experiments of his own designed to elucidate the nature of the phenomena, the author has also recomputed the data of other experimenters and obtained results which show some mutual agreement and tend to substantiate the explanation previously given and offer a method for estimation of such effects.

The author has found no satisfactory way of representing these effects analytically by the use of the conventional energy equation. He has, therefore, developed an energy equation which, he believes, represents more closely the actual facts of the case by ascribing a smaller velocity head to the water at section (o) about to leave through the take-off than the average velocity head at this section. The ratio of the velocity head of this water about to leave through the take-off to the computed average velocity head at section (o) is called C and its value is computed by the application of the energy equation which states that the rate of energy or power passing section (o) equals the power passing section (d) plus the power withdrawn from the pipe by the side stream. An additional term of small importance has also been introduced to allow for an expected small friction loss in the straight-flowing stream.

This equation can be expressed analytically in terms of symbols similar to those employed by Vogel, one of the first experimenters[1a]:

$Q = Q_a + Q_d$, or rate of flow approaching the take-off
Q_a is the rate of flow through the take-off, called side flow

*p. 89

Q_d is the rate of flow straight through the fitting past the take-off, called straight flow

V, V_a, V_d are corresponding average velocities; $V = Q \div$ pipe area.

h, h_a, h_d are pressure heads in corresponding pipes

w is the unit weight of fluid

g is the acceleration of gravity

$r = Q_a/Q$, or the ratio of side flow to approach, or total, flow

C is the ratio of velocity head of water at (o) about to leave to the average velocity head at this section

$Qw\left(h + \frac{V^2}{2g}\right)$ is the power approaching section of take-off

$Q_d w\left(h_d + \frac{V_d^2}{2g}\right)$ is the power of straight-flowing stream leaving take-off

$Q_a w\left(h_a + \frac{V_a^2}{2g}\right)$ is the power of the side stream at (a) but

$Q_a w\left(h + C\frac{V^2}{2g}\right)$ is the power withdrawn from the pipe by the side stream

The author has assumed that there is a loss of head in the straight flowing stream Q_d which is the same as that due to sudden enlargements: $\frac{(V-V_d)^2}{2g}$ A theoretical derivation of the loss in this case by the conventional methods used for sudden enlargement indicates to the author that this assumption of head loss in the straight-flowing stream may be somewhat too large. However, to neglect this loss altogether would lead to entirely unreasonable values at high values of r where this head loss is certainly considerable. The computed effect of this head loss at low values of r is slight. (It happens that the author is most interested in this region of the curve which is applicable to the case of perforated pipes.) The practical value of the assumption is that it makes all values of C less than unity, or one, and amenable to simple algebraic representation. No error, of course, will result if one is consistent in the use of the assumptions chosen.

The application of the conservation of energy principle results in the following equation:

$$Qw\left(\frac{V^2}{2g} + h\right) = Q_d w\left[\frac{V_d^2}{2g} + h_d + \frac{(V-V_d)^2}{2g}\right] + Q_a w\left(C\frac{V^2}{2g} + h\right)$$

Apparently the late Professor Goodenough defined his constants in nearly the same way as is done here while developing his formula for pressure in the models of the ventilation ducts of the Holland tunnel [4,5]. The author in his experiments computed the values of C directly from this equation.

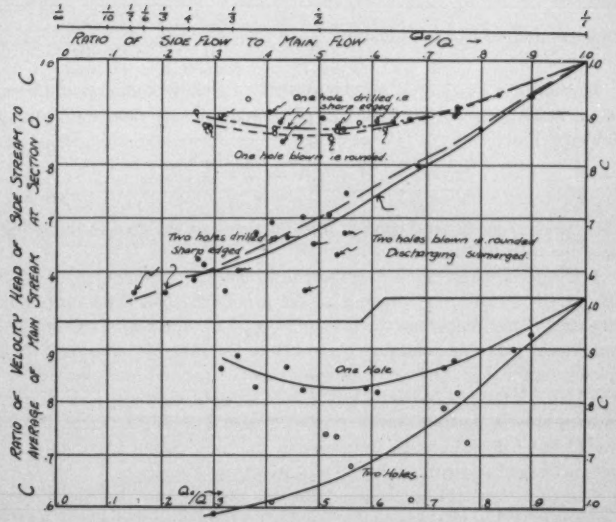
Ratio of Side Flow to Main Flow
Q2/Q
C Ratio of Velocity Head of Side Stream to Average of Main Stream
C Ratio of Side Stream at Section 0
One hole drilled: sharp edged
One hole blown: rounded
Two holes drilled: sharp edged
Two holes blown: rounded
Discharging Submerged
One Hole
Two Holes

FIG. 2

Upper Curves: Tests on Holes in Glass Pipes performed by W. E. Howland, W. J. Cunningham and K. S. Hollis.

Pipe diameter: 1½ in.
Hole diameters: Single, 0.70 in.
Double, 0.50 in.

Lower Curves: Tests on Sharp-edged Holes in Wrought-Iron Pipes performed by W. E. Howland, C. E. Ford and O. E. Campbell.

Pipe diameter: 1½ in.
Hole diameters: Single, 0.66 in.
Double, 0.52 in.

In order to compute the values of C from the Munich experiment it is necessary to apply the following equation which follows as an algebraic consequence of the preceding equations and definitions.

$$\left(1 - C\right) = \left(\frac{1}{r} - 1\right) \left(r^2 - k_d\right)$$

Here k_d is defined by the equation $\frac{V^2}{2g} + h = \frac{V_d^2}{2g} + h_d + k_d \frac{V^2}{2g}$

However, in the case of the experiments of Oakey[6] a somewhat different relation holds between the values of C, w, and the empirical coefficient K_2 obtained. Thus

$$C = 3 - 4r + 2r^2 - \left(\frac{1 - r}{r}\right) K_2$$

K_2 is a rather complicated concept and the reader is referred to the original article[6] for its definition.

It would be desirable to describe the author's experiments in detail, but suffice it to say that the pressures were measured with three open piezometer tubes, one located at the take-off, one, 5 in. upstream, and one, 9 in. downstream, all being tested in place before the take-off holes were drilled or blown in the pipe; that pipe friction was determined and allowed for as in the Munich tests; and that a long run of straight pipe was located on the upstream side of the take-off section of approximately the same diameter to avoid local disturbances. Pressures in the pipe varied from about 1 to 4 feet and velocities from about 4.5 to 0.9 feet per second.

One very interesting phenomenon was observed in the course of the experiments. When the downstream valve on the main pipe was closed and all the water passed out through two side orifices, a vortex was formed within the pipe, the hollow center of which extended entirely across the glass pipe. This effect was accompanied by a marked decrease in the coefficient of discharge of the orifices. It is thought that similar vortex formation may have occasioned the abnormally low coefficient noted by Enger[8] at the closed end of the perforated pipe which he studied.

The results of the author's tests and the values of C computed by him from data furnished by other observers are plotted in Figures 2–4. The Munich tests cover a wide range of type of fittings, but only the values for the sharp edged fittings have been plotted. The brass fittings tested by Oakey were apparently closely similiar to those studied at Munich. All of these were very smooth and regular, their interior consisting of true cylindrical surfaces.

A study of Figures 2–4 permits drawing the following conclusions:

1. The greater the diameter of the branch in relation to the diameter of the main pipe, the less is the value of C. Compare individual curves in each series of curves of Figure 3.

2. The less the ratio of side flow to main flow, the less is the value of C. See all curves, Figure 2–4.

3. Rounding of the edges may decrease slightly the value of C. See upper curve series of Figure 2.

4. There is no clearly defined relation between the angle of take-off and the value of C, although there is some indication that the sharper the angle

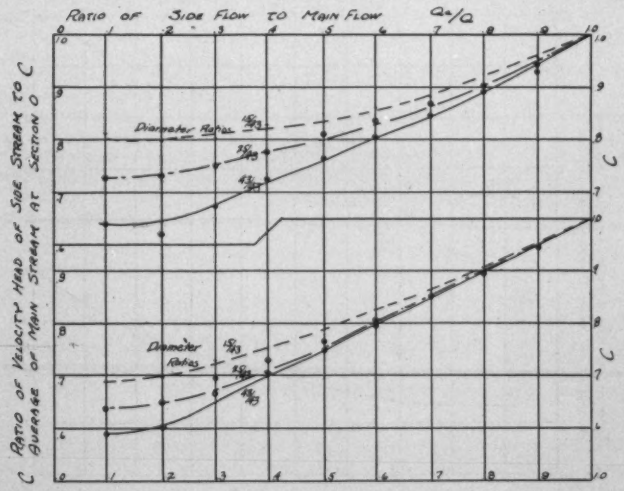
Ratio of Side Flow to Main Flow Qs/Q
C Ratio of Velocity Head of Side Stream to Average of Main Stream at Section 0
Diameter Ratios
Diameter Ratios
C
C

FIG. 3

Munich Tests on Sharp-edged Tee Branch Fittings with Various Ratios of Diameter of Branch to that of Main Pipe. Points computed by W. E. Howland from published curves of ξ_d, not from original data. Reference [1c].

Upper Curves: 60-degree fittings

Lower Curves: 45-degree fittings

and the greater the area of the eliptical-shaped opening in the main pipe, the less the value of C. Compare upper and lower curve series of Figure 3.

5. When water is taken from the pipe at two opposite points in the section, the value of C is very much less, other things being the same, than when the same quantity is taken out at one section. Compare individual curves in curve series of Figure 2. This important fact helps to explain certain apparent disagreements between the experiments of Malishewsky[7] and those of M. L. Enger[8].

6. Nearly the same value of C is obtained with orifices as with branches or tubes. Compare curve series of Figure 2 with those of Figures 3 and 4.

7. Submerging the orifices does not appreciably affect the value of C. See upper curve series of Figure 2.

8. Roughness seems to decrease the value of C. Compare curve series of Figure 2.

9. From all of these facts it would seem that increasing the opportunity for taking off the slow-moving edge layers will decrease the value of

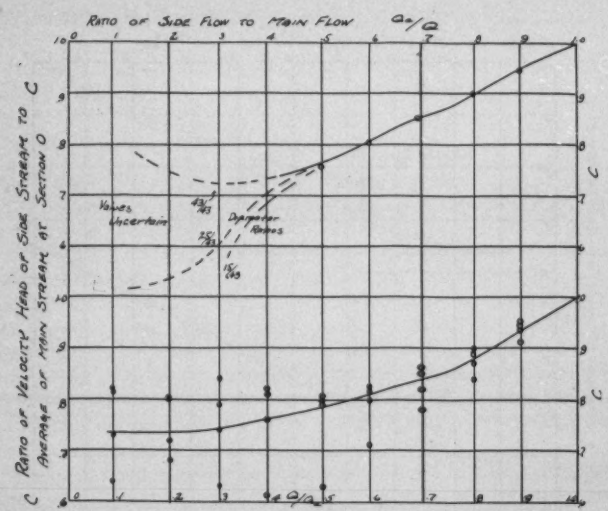
Ratio of Side Flow to Main Flow Q_s/Q
C Ratio of Velocity Head of Side Stream to Average of Main Stream at Section O
Values Uncertain
Diameter Ratios
C

FIG. 4

Upper Curves: Munich Tests of Sharp-edged 90-degree Tee Branch Fittings with Various Ratios of Diameter of Branch to that of Main Pipe. Points computed by W. E. Howland from published curves of ξ_d, not from original data. References [1a] and [1d].

Lower Curves: Tests by J. A. Oakey of Sharp-edged 90-degree Tee Branch Fittings with Ratios of Branch to that of Main Pipe Ranging from 1:1.21 to 1:4.24. Points computed by W. E. Howland from published values of K'. Reference [4].

C and this implies that the value of C may be largely determined by the relative slowness of the water so removed.

10. Owing to the difficulty in securing precision of measurements and of computations at low values of the ratio of side to main flow, it is thought that the values of C at these lower ratios are less reliable. It is entirely possible that the value of C will drop toward the theoretical limit of zero at exceedingly low values of the flow ratio, but surely a single straight line relationship going from $C = 0$, where the flow ratio is 0, to $C = 1$, where the flow ratio is 1.0, is not supported by the data.

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EXPERIENCES WITH THE PUBLIC WORKS ADMINISTRATION AND OTHER GOVERNMENTAL AGENCIES FOR PUBLIC WORKS CONSTRUCTION.

A SYMPOSIUM.

[*September 19, 1934.*]

INTRODUCTION.

BY FRANK A. BARBOUR.*

There are six† scheduled speakers,—two Public Works Administration state engineers, three representatives of state health departments, and one engineer in private practice.

I take it that the projection of this symposium was based on the assumption that there would be a frank, constructive discussion, and we may assume that we shall be credited with good intentions in the situation. I cannot see much profit unless the discussion is made critical, but criticism should, so far as possible, be made constructive.

Yesterday‡ you listened to a discussion of the basic formula on which the Public Works Administration (PWA) is founded, namely, whether this country can spend itself out of a depression, or whether, by a broad scale program of public works construction, business can be stimulated to the point of relieving unemployment. Opinions, of course, differ on this question of the soundness of the program, or as to the ultimate success of the program; but in my opinion there can be no doubt that up to the present time the PWA, so far as it may be responsible, has failed to so stimulate business as to improve materially the unemployment situation. That this is true is rather well evidenced by the anticipated need throughout the coming winter of a relief program on a bigger scale than has ever been necessary before. How far this failure is due to the fundamental basis of the program or to the methods of procedure is of course a question. I take it that this session today will largely have to do with the methods of executing the program.

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*Consulting Engineer, Boston, Mass., Chairman.

†At the request of one of the speakers, his remarks are not included in the Journal.

‡See Papers by W. T. Chevalier and R. S. Meriam in the December, 1934, issue of this JOURNAL.

Experiences with the Public Works Administration in New Hampshire, Maine and Vermont.

BY HAROLD J. LOCKWOOD.*

I appreciate the honor of addressing you on "Experiences With Public Works Administration," particularly as I am a newly elected member of your organization. I have also had the pleasure of working with some of you in the Public Works Program; some of our experiences have been pleasant; and some, not so pleasant. There are probably many things open to criticism, but we are not here just to criticize. Many people doubt the fundamental philosophy of *spending* our way out of a depression, but none of us want to see people in distress or out of work. However, those of us who have given work to many of the unemployed have, perhaps, come to the conclusion that even in periods of greatest prosperity many of the same individuals would still be unemployed. Again, if my appointment had been made this fall, with the present experience of the Public Works Administration behind me, my task and yours would have been much easier.

One of our Vermont friends relates a story which may be used to explain why some criticize government agencies. "One of our citizens, badly boozed and bewildered, blundered into the river and was drowning. Our whiskered sheriff, grabbing the first rope he could lay his hands on, went on the run and pulled him out. While he was still in the water he never ceased yelling, between mouthfuls of Waits river water, 'Save me, Sheriff, Save me!' But when he was out and had got his breath, he began to criticize, 'Look at that rope you throwed me! That's a fine rope ain't it! It might a busted and then where'd I been?' 'And besides', he added, eyeing the sheriff reproachfully, 'I never did like them whiskers.'"

The experience of a State Engineer, PWA, is rather one-sided in that he represents the Government Administrator and can present facts from that viewpoint alone. My connection with Public Works started with an administration which was set up in New Hampshire by Governor Winant early in the Spring of 1933, and I was in Washington at the time the Recovery Act was signed in June, 1933. My first appointment came as a member of the Advisory Board. Because of the death of a member of the Board, the Advisory Board was ultimately reorganized and on August 15, 1933, I became State Engineer. No attempt will be made in this discussion to provide statistics, except to remind you that the larger portion of our work in the three states,— Maine, New Hampshire and Vermont,— has been with water works and sewerage. Mimeographed releases and orders came out very rapidly from the outset and placed a severe burden on the State Engineer in his endeavor to interpret and carry out these orders. Although no excuse, he may not be aware of a certain method of operation although it exists. It is also extremely difficult at times to find the authority

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for a certain procedure. Older government agencies have had the time to create proper indices and records for quickly finding and rendering decisions on such matters. All of our work has started from scratch and has been a high-pressure operation.

So far as the general plan of operation, most of you are familiar with the set-up of the Public Works Administration, so I need not dwell on that phase. In the discussion to follow, I shall be glad to try to answer any questions. The purpose underlying the entire scheme was,— "To increase the consumption of industrial and agricultural products by increasing purchasing power; to reduce and relieve unemployment; to improve standards of labor, and otherwise rehabilitate industry and to conserve national resources."

We were able to have passed by the New Hampshire Legislature *an Enabling Act*, which has helped us very much. This was passed shortly after the National Recovery Act. Many states were legally handicapped by the lack of similar enabling acts, and still are in difficulties.

The Public Works Administration was an entirely new organization, which grew almost over night, and many, untried in government work, were taken into the outfit. Many policies were changed, in some cases as a result of conflict in some other district. Some states had no enabling acts, and under the present set-up, no progress could be made. Many states were over-legislated, such as Massachusetts. It was a tremendous job to write agreements satisfactory to all.

In the loaning of money, and in the case of grants, too, the authorities have had in mind the protection of the public bodies' interests. We found bond counsel, which was limited in the beginning to two nationally known bond houses in Boston for the New England District, very cautious and, in fact, discouraging when opportunity presented itself to advise the municipalities to sell their bonds to the Government. When the Legal Division passed the initial peak load the necessity of outside bond counsel was removed.

The New England States had to put up with a scrutiny of bond issues and other legal and financial matters beyond that experienced before, due to the fact that all rules were promulgated for the entire United States, and we cannot overlook the fact that many states were in poor financial condition and in the past, bond issues had perhaps not been handled correctly. There is a grave issue before all of us as to the policy of states in their supervision over municipal finance. Legislatures are apt to be too friendly to their own municipalities, so that holders of bonds may find themselves in a very uncertain status.

Attention should be called to the fundamental difference in operation under Government agencies between outright allotment of federal funds as compared to the case of loaning money to states and municipalities. In order to expedite work, large sums of money were turned over to such Government units as the Navy, Army, Agriculture, etc. These departments

had, in many instances, plans all made and the supervision by PWA was practically turned over to these departments. All highway work has been turned over from our office to that of the Bureau of Public Roads. The various highway departments then established their own minimum wage rates and hours. Many conflicting rulings have resulted from this division of authority. From my own experience, I have found that wherever I have been aware of conflicts, the parties concerned have made every effort to institute corrective measures.

Delays in government operation are very often due to the tremendous size of the functional organization and to the time it takes to reach the official who is to make the decision. The official comes to the conclusion that he will take no responsibility beyond his immediate sphere. There is also a reluctance to assume responsibility, because, no matter how carefully all matters are prepared for execution, the Comptroller General of the United States is the final authority for payment. Even in the cases of emergency agencies, the ultimate payment or clearance may be troublesome. Contact and experience with Government agencies reach back to men connected with emergency posts and infect them with many traits whether good or bad.

On the supposition that the work may be done more cheaply, too many communities are making municipal improvements by "day work." With labor paid by some relief group, all the town does is to buy materials. At first the PWA was rather liberal and we were allowed to approve force-account method on some of our projects. Our experience has been that plans are not sufficiently developed and that, more often than not, costs over-run, and in the end the town does not profit by the day-work-method. This is particularly true in the face of the stringently enforced labor preference provisions of the PWA. It seems to be true that nearly all force-account requests find as a base the desire of the community to obtain employment for its own citizens.

State Engineers were not sure just how far their authority extended and to what extent they would be backed. My experience has been fairly happy in this respect because I may say in all frankness that the Administrator and his staff have backed me in nearly all cases. Owing to the many phases of operations, apparent useless duplication of effort has resulted. It has been a question of "going to school" for all of us, and now we know "which teacher we can get along with the best."

We have been dealing for the most part with people unfamiliar with Government agencies. Many of our New England friends resent any outside interference. Instead of finding out the rules and then playing the game, they are inclined to start to play and then try to find rules to cover the way they play. It is true that PWA authorities did not sufficiently clarify instructions in the beginning. It was a long time before I could compute the amount of grant on a project. Many of our difficulties may

be traced directly to the essential difference in operation between lawyers and engineers.

Outside influences caused much of our earlier trouble. There was a tendency to side-step the office of the State Engineer and go directly to Washington. I will say that in practically every case any matter conducted this way was referred back to the State Engineer. Naturally, I am speaking of experience in my own territory.

There was no intention on the part of the Administrator to change any of the normal procedures of the construction industry. Many of our dealings with engineers have led us to believe that they are entirely too modest. The contractors who have given us the most trouble have been of the type who would have given any engineer trouble, even in normal times and on private work.

We attempted to use the so-called "Huddleston Plan" of bidding with the result that our staff was caused a lot of extra work. Apparently those most vitally affected appreciated our efforts the least. It was finally dropped. It would seem as if some engineers, contractors, and others are not particularly in sympathy with any movement that would attempt to eradicate bad practices. Bid-peddling with all its evils would be eliminated under the Huddleston or similar plan, and jobs let on an equitable basis to all concerned.

The close bidding which more or less prevails in our district at present, I believe, is due to better specifications, clearer statement of wage scales and hours, and in general to the clarity of our instructions to all bidders in relation to the requirements of the administration.

The task we must face is that, with all the spending by government agencies, there must be no hue and cry that certain communities were favored. Administrator Ickes has recommended a long-range program of Public Works, and this seems a logical step forward. There should be a central coördinating body handling all Federal construction work except possibly some exempted units, such as TVA. Yet the same rules as to wage scales, hours, and workmen should apply to districts with better subdivisions of these districts. Rural Maine, New Hampshire and Vermont should not be in the same wage brackets as metropolitan Boston and New York.

It might be a good policy for the Public Works Administration to serve as a branch of the Federal Government organized to step into an economic breach with work to take up the slack with a well developed program, funds for which may be provided as prior loans are redeemed and by some additional appropriations. It is essential to have more uniform regulations and rates among various agencies. It seems to me that our mayors of cities and selectmen of our lesser public bodies are faced with too much responsibility in connection with relief and public works. The local authorities have to shop around among the various government agencies to see how a certain project may be best accomplished.

My experience would indicate that PWA might well control in general all forms of public works, but that the procedure on a particular job should be governed by the amount involved or the department concerned. Different classifications of non-Federal works might be along the line of amount involved; Class I, Public Works over $500,000; Class II, $100,000 to $500,000; Class III up to $100,000. As experience in handling projects is gained, these valuations might be shifted in amount.

With more decentralization it will be possible to construct public works in the future very quickly, efficiently, and with the least possible "red-tape." PWA has come a long way since last year, yet we must not fail to note that many of the delays either on one side or the other are quite often welcomed.

Two important changes should be given considerable thought. At the present time the State Engineer is required to award a contract to the lowest responsible bidder. This has placed many projects in our territory in the hands of out-of-state contractors so that our local contractors have lost out. Where local money provides a large share of financing of the project, more consideration should be given the local concerns. The second matter is that of hours of work. Under the emergency conditions, short hours and many shifts were no doubt advisable. However, under less trying conditions, hours of labor and rates of pay should conform more nearly to customary practice and to the local prevailing rates of pay.

With the best of intentions, various Government agencies were set up to help in providing unemployment relief. Many of these agencies, such as CCC, CWA and other alphabetial combinations have accomplished quick placement of large sums of money. At the present time FERA is doing a great deal towards giving employment. The most serious point that develops from all this is that contractors are not getting as many jobs as they should.

To effectuate and facilitate the recovery program, many Federal agencies have been established together with various coördinating agencies, local in nature. It is not inconceivable that much good which might otherwise be accomplished through these means meets resistance or defeat in the inherent tendency selfishly to promote individual rather than general welfare.

If nothing else results from PWA, I believe that balanced budgets, better town records, etc. will result, as the Administrator has followed this phase very carefully as evidenced by the balancing of budgets in many large cities.

In conclusion, I must state that official Washington has been most cordial and coöperative. Misunderstandings have arisen, but when cleared, action has resulted promptly.

The coöperation, confidence and aid of the consulting engineers and architects have been the means of continuing a somewhat difficult task.

Experiences with the Public Works Administration.

An Engineer's Viewpoint.

BY ARTHUR L. SHAW.*

Topical discussions of subjects such as the Public Works Administration strongly tend towards adverse criticism. Unpleasant experiences are apt to make the strongest impressions and to be given most prominence in the discussion because it is human nature to take the pleasanter things for granted. It is also natural to blame the local Federal officials, whose duty it is to enforce and administer PWA requirements, forgetting that these Federal men are as much bound by rules and regulations issued from the central authority in Washington as are the municipalities and contractors that have committed themselves to PWA projects. It may be of interest, therefore, to view some of the problems from both sides and perhaps to discover that such difficulties as have arisen may be a necessary part of the conduct of governmental undertakings such as the PWA.

It must be admitted at the outset that city and town officials, contractors, and engineers, have quite generally been irritated by PWA formality — red tape, if you will — that has required PWA projects to be conducted in ways which are quite foreign to customary practice on similar undertakings under normal circumstances. This irritation is doubtless caused largely by the natural aversion that people have to doing things in other than accustomed ways.

Municipal officials find themselves inconvenienced by the greatly increased formality of arranging Federal Loans, as compared with their usual experiences in borrowing from the banks. Several months often elapse after allocation of money to a project before cash is finally made available, whereas most municipalities are able to negotiate loans with local banks in a few days. This delay may be accounted for if it is remembered that the local bank has usually loaned money to the city previously, and being familiar with local conditions, can act promptly; whereas, to PWA headquarters in Washington, each city or town is just one of thousands, and it is deemed necessary to study critically and check every detail of the city charter, the legal mechanism provided for borrowing, and minute statistics relating to the city's tax and financial situation, before risking a loan.

It may be argued that such detailed scrutiny is unwarranted in view of the fact that cities and towns have usually been borrowing successfully under their charters for a long time, and that such evidence should at once satisfy the Federal government. It has been said, however, that the PWA attorneys have in certain instances discovered that municipalities have been borrowing illegally for years due to incorrect use of the mechanism provided by their charters. It is undoubtedly a good thing to have such errors

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in municipal financing discovered and corrected. Furthermore the act authorizing Federal loans stipulates that they shall be "reasonably" secured, and any official in whom is vested the responsibility is bound to take steps to assure such security. This not only requires an appraisal of the financial status of the borrower but a determination of the conditions under which he may borrow in conformity with law.

The *contractor* on PWA work meets certain requirements which are definitely burdensome to him and to which he is unaccustomed. The most drastic change from usual procedure, from the contractor's point of view, is his loss of control over his labor supply.

Contractors complain that the men sent to them by the local Federal Reëmployment Offices are unsuited for hard manual labor, and that the turnover is so high, due to the voluntary dropping out of men unable to stand the work, that efficiency and progress are seriously affected. This has been particularly noticeable in communities lying near several PWA projects, the combined labor requirements of which overtax the supply of qualified local men. However, the labor requirements are clearly stated in the PWA contract clauses, and the purpose of PWA work has always been understood to favor local employment. There should be, therefore, no complaint on this score, although many contractors appear to have failed to provide for it adequately in making their bids for PWA projects and have suffered hardship on that account. This is particularly true in the earlier work before the operation of PWA requirements was fully understood. More recent bidding indicates an appreciation of the cost of the limitations on labor and other items, although it does not appear that the increased cost has been sufficient to fully offset the Federal grant.

It has been noticeable that some contractors lose interest and decline to bid when they learn that forthcoming contracts are to be under PWA. This tendency manifests itself in the small number of bidders on PWA work of types which would seem to be attractive to many. Nevertheless the number of bidders has been sufficient to assure adequate competition.

Engineers in charge of the construction of PWA projects probably find their principal grievance in the enforced subservience to PWA officials under circumstances in which the engineer has customarily been in full control of his undertaking. This is particularly disconcerting because the loss of authority is not accompanied by a compensating relief from responsibility. The simplest changes in plan or specifications, decisions as to the need and cost of which are customarily made by the engineer from time to time as the work progresses, must now await approval of a formal application passed through official channels.

In principle, this Federal control in respect to approval of what shall or shall not be done is very similar to that which the departments of health in most states have exercised for years over water supply, sewage disposal and other public health projects. The difference seems to be largely that engineers are accustomed to the latter and not to the former.

Engineering for PWA projects costs more than for ordinary work due to time consumed in obtaining approval and authorization on matters usually settled by the engineer without formality, limitations as to hours of work by the field staff and the paper work involved in the required forms of reports and estimates. This is unavoidable, granting that supervision by PWA engineers and auditors is a necessary part of the plan.

Federal control has for its purpose the safeguarding of its financial and social interest in the project. The determination of the amount of the Federal grant is an accounting matter; therefore, it may be reasoned that all items of work which may figure in this calculation must be under regular and systematic scrutiny; and, since one aim of PWA is the creation of employment, with local preference, the enforcement of labor requirements may well be felt to be a paramount Federal duty to the community which must ultimately pay the bill.

There can be no doubt that the governmental changes which have been taking place will continue to create indignation in many quarters among those whose prerogatives, established by long custom, are interfered with. The PWA, as one phase of the current experiment, is no exception. Criticism loses its force if unaccompanied by constructive suggestions, and, assuming the fact of a Federal Public Works program, it is difficult to see how it could be managed much differently, on the whole, without loss of some of the safeguards that seem essential to avoid future embarrassment. As in all things, the way to get on most smoothly is to play the game according to the rules, as long as the rules are in force.

Federal Aid for Water and Sewerage Works in Connecticut.

BY WARREN J. SCOTT.*

The policy of extending Federal financial aid in public works construction has had extremely small effect on waterworks construction in Connecticut and a somewhat limited effect upon sewerage construction, as related to new projects of major size, but many individual improvements have been made.

Through the kindness of Leslie A. Hoffman, Federal PWA Engineer for the state of Connecticut, the following information is furnished as to PWA projects in Connecticut which had been approved for grants, or loans and grants by Washington, as of August 31, 1934. All of these projects have not been sanctioned by the voters, and in some cases delay has occurred because of difficulties with financing.

Types of Projects.	Number of Projects.	Total Estimated Construction Costs.	Per cent. of All Projects.
Waterworks	1	$ 259 000	1.5
Sewerage	11	5 736 904	32.7
Highways	70	8 885 191	50.7
Schools	12	2 118 397	12.1
Golf course, fire house, etc.	3	520 780	3.0
Total	97	$17 520 272	100.0

It is of some interest that the waterworks project of the First Taxing District of Norwalk was the first PWA project approved in Connecticut and the only waterworks project so far authorized.

There are perhaps four main reasons why waterworks projects have not been undertaken in Connecticut. In the first place, of 102 systems in Connecticut supplying water to the public, 80 are privately owned and were not subject to Federal aid. Secondly, during the past ten years we have seen several drought periods as a result of which additions to the existing sources of supply had been made in great or small magnitude. In consequence practically all of our supplies were in pretty good shape so far as adequacy is concerned when the depression began. Moreover, with the beginning of the depression, water consumption in our industrial cities commenced to fall off, making problems of future water supply adequacy less acute. Third, there has been a lack of adequate plans for major extensions of water distribution systems. Lastly there is unquestionably not the marked enthusiasm for financing with Federal aid in Connecticut that has existed elsewhere. One of the largest waterworks projects in Connecticut for a number of years is the development of the new Hartford Metropolitan District water supply which will involve an estimated ultimate expenditure

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of some $8 500 000. This has been placed actively under way since the beginning of the PWA, without any outside financial aid.

As seen from the tabulation of projects, the number of sewerage projects involving new collecting sewers and construction and enlargement of new sewage disposal plants has been much greater than in the waterworks field. Of the eleven sewerage projects, only two are for new disposal plants, viz., Hartford and Milford. The Milford project with a total estimated cost of $934 000 has recently been turned down by the voters so that this project should really be removed from the table.

Work in the waterworks field under the CWA and FERA has been applied mainly to cleaning of vegetation from watersheds, reforestation of watersheds and laying of new water mains. However, new reservoirs were constructed with FERA aid at the Connecticut State Hospital in Middletown and on the watershed of the city of Middletown, and last week the city of Willimantic voted to proceed with the construction of a water filtration plant with the aid of FERA funds. This latter project will probably cost close to $100 000.

Despite the fact that the individual waterworks projects have for the most part been of relatively small magnitude, the total of expenditures for labor and materials on waterworks projects under the CWA and FERA in Connecticut has reached the relatively large figure of $833 382.33. Of this total, about 70 per cent. was for labor. These figures and subsequent figures for sewerage projects were recently furnished the writer through the kindness of F. Perry Close, State Engineer for the CWA and FERA.

The financial arrangement under the CWA permitted some contributions for materials by Federal funds but under the FERA no expenditures for materials were authorized by the Federal Government. It is possible that if future funds are allocated, provisions for Federal expenditures for materials may be made.

New sewage treatment plants at Putnam, Stafford Springs and Tariffville are being built with CWA and FERA assistance, and Willimantic has just authorized the building of a sewage screening plant as an FERA project. A fairly extensive and needed addition at the Ridgefield plant was also financed with FERA and town funds, and re-building of filters and alteration of existing plant facilities were carried out at Bristol, Danbury and one or two other places. Extension of lateral sewers where construction costs would be paid by assessments against benefiting property owners was not undertaken by the CWA or FERA, but some main trunk sewers were built.

The total cost of authorized CWA and FERA projects involving construction of sanitary sewers and sewage treatment plants amounts to $968 297.90. Of this amount, about 62 per cent. comprises expenditure for labor. These figures do not include expenditures for storm sewers which were built under the FERA. The total estimated cost of storm sewers is $353 167.53.

Local officials have been alive to the possibilities of cutting down local relief expenditures, and where they had projects before them, they were quick to seek Federal CWA and FERA grants. It is worthy of note that the FERA engineers have done some good missionary work in getting funds diverted to worth while water and sewerage projects rather than in some other directions where less benefit would be obtained. Engineers paid by FERA funds have been assigned to local communities to help in drafting plans for public works improvements to be executed under the direction of consulting engineers. The purpose of this engineering aid has been not only to furnish employment to engineers but also to help whip into shape some needed projects that have existed in vague form.

The policy of providing work for engineers has, of course, a great deal to commend it. It is to be hoped, however, that supervisory authorities will insist that any engineering work which is undertaken will be under competent direction by engineers with specialized training wherever specialized engineering knowledge is needed. This need applies to water and sewage treatment projects. It would, naturally, be poor economy to authorize relatively small expenditures for engineering service and on the basis of incomplete information, to go ahead with large expenditures which are not headed in the right direction.

As a whole, it seems to the writer that the uncertainties of the extent of Federal aid for actual purchases or expenditures for labor payrolls for very long in advance make the CWA and FERA less effective agencies for extended waterworks and sewerage projects than such agencies as the PWA. The CWA and FERA were emergency relief agencies and can not be expected to function largely in the public works scheme. It should be stated, however, that in Connecticut many worth while accomplishments in the waterworks and sewerage fields, for the most part of a minor nature individually, were carried out. Moreover, because of the fact that Federal funds were available and money had to be expended for relief, FERA engineers in some instances were able to put across projects that did not appear sufficiently attractive to the communities to go through under the PWA.

Before the PWA came into being, the writer was asked to prepare a list of waterworks and sewerage projects which in his opinion might be carried out to the benefit of the public. At that time the writer estimated that $10 000 000 might readily and beneficially be expended for needed waterworks construction in Connecticut. $8 500 000 of this was for the Hartford project which is now under way without Federal aid up to the present and of the remaining $1 500 000, only about half was for municipally owned supplies. It was also estimated that $16 300 000 might well be spent for: (1) new sewer collecting systems including new disposal plants, (2) new treatment plants for existing systems and (3) additions to existing treatment plants. Similar lists were prepared by state sanitary engineers throughout the country.

The total of these lists throughout the country presented an imposing figure. Moreover, needed waterworks and sewerage project cost estimates would be greatly increased by including extensions of water mains and collecting sewers to serve new territory as well as strengthening of water distribution systems by additional feeders, all of which could not be included frequently in the state sanitary engineer's estimates because of lack of information.

Unfortunately, in considering these lists, it must be borne in mind that local support for many of these projects has not even yet been developed. The lists may appear imposing, but when the voters turn down many projects, the lists may shrink materially. For example, some of our Connecticut water supplies are in need of filtration to improve the physical character of the water, even though the particular supplies may be protected by the existence of clean watersheds, storage and chlorination. It frequently takes a long period of time before the local community gets "steamed up" to the point where the desire for more palatable and attractive water overcomes the reluctance to make the expenditure. In the sewerage field, progress is even slower. We have at present no water supplies in Connecticut which receive any discharge from public sewers. With polluted shellfish areas already closed, with epidemiological evidence as to dangers from bathing in polluted waters rather indefinite, and with considerable lethargy among the public toward the abatement of nuisance conditions, destruction of fish life and other stream pollution considerations, the gaining of public support for sewerage projects frequently cannot be obtained as rapidly as supervisory officials would wish.

For public works construction to fit into our scheme of economic recovery in times of financial depression, it is self-evident that long-term planning is needed. If engineering studies of needed waterworks and sewerage construction, as well as other public works construction, could be carried along in good times as well as in bad times, so that when the need for relieving unemployment arrives, the public may have before it for consideration well planned projects already conceived in their entirety, public works stand as real weapons for economic relief. But if it become necessary to convince the public on the basis of a hasty engineering survey, made after a depression arrives, public works are far less effective means of economic aid.

Experiences with the Public Works Administration in Public Works Construction and Other Government Agencies in New York State.

BY EARL DEVENDORF.*

During the past year prominent government officials and engineers have presented many papers in the engineering and water-works journals which have discussed various phases of public works construction undertaken or proposed with federal aid as an aid to economic recovery. It will be my purpose to present a brief summary of the experiences in New York State during the past three years in the construction of sanitary projects with federal aid.

Since 1931, I have devoted practically my entire time and effort to coöperating with municipalities in New York State in the undertaking of needed sanitary public-works projects as a means of relieving unemployment. The state engineer, Arthur S. Tuttle, of the PWA and the State Advisory Board, appointed to examine and pass on public works projects under the National Industrial Recovery Act, requested my assignment in September, 1933, to assist the State Engineer in the examination of plans for sanitary projects in New York State.

Later, I was appointed by Governor Herbert H. Lehman to take up with the Public Works Administration matters in connection with sanitary projects proposed to be undertaken by New York State municipalities which were pending before the Administration in Washington. Also, at the request of the State Temporary Emergency Relief Administration, I have assisted that organization in connection with Public Works relief and Civil Works projects. These assignments have given me an opportunity to become intimately familiar with the water supply, sewerage and incinerator projects from the local, state and federal standpoint.

New York State Laws Enacted for Relief of Unemployment.

New York State was the first state to provide material assistance to the local units of government in the provision of relief to indigent citizens. The local units could no longer carry the relief load alone, and state aid was made necessary by the prolonged duration of the economic depression. By an act passed at the special session of the legislature called in 1931 by the former Governor, Honorable Franklin D. Roosevelt, the State of New York declared that "an emergency existed in which both the public health and safety of the state and of each county, city and town therein was imperilled by the existing and threatened deprivation of a considerable number of their inhabitants of the necessities of life."

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The New York State Legislature has also enacted a number of laws during the past two years to facilitate the construction of needed public works projects. These laws authorize the undertaking of needed public works improvements by a vote of the governing board without the necessity of having a referendum vote, provided the construction work is undertaken with federal aid for the relief of unemployment. These laws have thus permitted municipalities to construct work relief projects without unnecessary delay.

Statement Regarding Relief Moneys Spent in New York State.

The Temporary Emergency Relief Administration was established for the administering of the Wick's Act under which local welfare districts were to be reimbursed from state funds up to forty per cent. of their home relief expenditures and given similar direct assistance for work relief in amounts to be determined by the Administration. With the continued and increasing need for assisting local welfare agencies the Legislature has extended the emergency period until it now includes the period up to February 15, 1935. Reimbursement to local relief agencies has been increased until at present 75 per cent. of the cost of home relief expenditures is reimbursed by state and federal funds. Work relief has been placed on an equal basis with home relief. Reimbursement on expenditures for materials, however, is at present limited to an amount not exceeding 33⅓ per cent. of the amount of labor. The cost of materials in excess of 33⅓ per cent. of the cost of labor must be borne by the municipality or the local relief administration.

The magnitude of the problem and the enormous cost of providing for relief in New York State is shown by the following data. During the month of July, 1934, the TERA reports expenditures and commitments for home relief, work relief wages, work project materials, transient programs, and other special forms of relief, and local and state administration amounting to $27 032 967 supplied by municipal, state, and federal funds. Of this amount it is estimated that approximately 23 per cent. will be paid for by local welfare districts and 77 per cent. by state and federal funds. Expenditures for home and work relief during July amounted to $20 721 184 of which 44 per cent. was spent for home relief and 56 per cent. for work relief. Approximately 1 998 600 individuals, representing 16 per cent. of the total population of the state, were beneficaries of relief during July. The percentage of population on relief rolls upstate and in New York City during July was 13 and 18 per cent. respectively. Some idea of the mounting cost of relief in New York State is shown by the following comparison of expenditures in July 1932, 1933 and 1934.

EXPENDITURES FOR RELIEF.

	July, 1932	July, 1933	July, 1934
State	$4 797 000	$11 011 000	$20 721 000
New York City	2 414 000	6 562 000	14 084 000
Up-state	2 383 000	4 449 000	6 637 000

During the two-year period from October, 1931, to November, 1933, moneys have been appropriated by the State Legislature and bond issues passed at general elections, amounting to $115 000 000. At the coming general election another bond issue is to be submitted to the voters for relief purposes amounting to $40 000 000.

These statements and figures on relief expenditures have been taken from reports of the State Temporary Emergency Relief Administration. These data indicate that widespread unemployment still exists in the state, affecting the sustenance of hundreds of thousands of citizens who, in normal times, supported themselves. Large expenditures in home relief have been made necessary in many instances through the inability of the local municipalities to finance their proportionate share of the cost of supervision, equipment, and materials needed to permit the construction of desirable public work projects in their localities under the present restrictions and requirements of the Temporary Emergency Relief Administration.

The following survey of new projects approved by the Temporary Emergency Relief Administration from January to October, 1933, indicates the wide range in types of the projects undertaken:

	Per cent. of Total New Projects
Highways	43.1
Utilities and Structures	12.8
Sanitation	12.0
Parks and Playgrounds	7.6
Water Supply	5.3
Clerical and Professional	7.8
General Public Improvements	3.8
Miscellaneous	7.6
	100.0

It is impracticable at this time to give a summary of the number and cost of sanitary projects undertaken with state and federal aid in New York State. There has been, however, a vast amount of such work undertaken and completed. These projects range from small projects to projects of large magnitude. As an example of the latter type may be given the construction of a sewer system and sewage treatment works for the village of Lawrence. The original estimated cost of this project was $550 000 and according to information obtained from the TERA it appears that the project was completed at a total cost of about $460 000. Examples of other types of sanitary construction projects undertaken with state and federal aid under the TERA include the following: Construction of water and sewer mains, wading pools, eradication of vermin, elimination of insanitary conditions in city dumps, repairs to existing water works and sewage treatment plants, painting water tanks and standpipes, straightening and cleaning creeks, construction and repairs to swimming pools, inspection of water system valves, surveys of sewer systems to determine the source of storm and ground-water infiltration, surveys of water systems to determine

leaks, lowering water mains, reforestation on city watersheds, surveys of boundaries of city watersheds, construction of incinerators, construction and repairs to water supply reservoirs, construction of additions to water supply systems, and extermination of mosquitoes and elimination of breeding places. A vast amount of work of this nature has been done on Long Island and in the city of New York.

During the past summer the Temporary Emergency Relief Administration appointed an advisory committee on planning for the purpose of stimulating and encouraging throughout the state projects for work relief of a more permanent nature than has generally been the case in work relief during the past three years. This was done in anticipation of an expansion of work relief during the coming winter. While it is expected that the source of labor for these projects will be relief labor and the extent of the relief load in any community will largely determine the extent of the projects that can be approved, it is expected that as a result of this activity a large number of projects covering construction of water works and sewerage will be undertaken. At the request of the Administration, the State Health Department has prepared a list of needed improvements in water supply and sewerage in many communities throughout the state. The Department has written and conferred with the officials of these municipalities, and in many cases the municipalities have already engaged engineers who are preparing plans for the proposed work so that when the money is made available the work can be started without delay such as has been the case with many of the projects in the past.

Public Works Administration Construction in New York State.

The provisions of Section II of the National Industrial Recovery Act passed by Congress in June, 1933, relating to the construction of public works with federal aid have been so widely discussed and are so generally known that it is not necessary to describe them before such a body as this.

The office of the State Engineer for New York State was established on August 22, 1933, and Arthur S. Tuttle, State Engineer, and the State Advisory Board began the examination of applications and plans covering a varied and large number of municipal construction projects proposed to be undertaken by municipalities in New York State. While the delay in initiating actual construction work on these projects has been disappointing in New York State as elsewhere, it is recognized that the task of the Federal Emergency Administrator of Public Works in carrying out the provisions of the act has been gigantic.

The following data obtained from the office of Arthur S. Tuttle, State PWA Engineer, indicates the large amount of construction work now under way.

About $73 000 000 is being spent in New York State on federal projects. Of this amount some $23 500 000 is being spent for public buildings, including 87 postal stations; about $22 300 000 is being spent on road work; about $19 000 000 is being expended for ship building; about $5 000 000 will be devoted to various river and harbor improvements; about $2 500 000 for repairs and replacements to federal buildings and about $500 000 for agencies such as the Geodetic Survey and Forest Service.

Four hundred and fifty-three applications for loans and/or grants for non-federal projects, amounting to about $342 000 000 have been filed by public bodies in New York State. Of these a number were subsequently withdrawn, some were rejected, others transferred to the Civil Works Administration, while others are yet awaiting allotments. Until additional funds are provided by Congress, many of these latter projects will be unable to be undertaken.

Up to date, allotments for loans and grants of over $181 000 000 have been made for 235 non-federal projects in New York State, which amount is to be supplemented by an additional $18 000 000 to be supplied by applicants who have secured federal grants. This makes a total volume of non-federal public works to be carried out in this state as a result of the Recovery Act of approximately $200 000 000.

These projects include 74 school buildings, 39 sewerage systems and sewage disposal plants, 35 water supply improvements, 29 street and bridge improvements, 10 hospitals, and 12 miscellaneous public buildings. It also includes 16 other projects, comprising housing, incinerators, light and power plants, water front improvements, the Triborough Bridge, Midtown Hudson Tunnel, and the completion of The City of New York Rapid Transit System.

These projects, to be financed by loans and grants, are distributed over the entire state. The value of the projects to be carried out in the cities of New York, Buffalo (including Erie County) and Rochester amount to $40 467 000, $8 741 000 and $3 003 000 respectively.

The major projects comprise the Midtown Hudson Tunnel, being carried out by the Port of New York Authority under a loan of $37 500 000, the benefit of which is shared by the State of New Jersey, and the Triboro Bridge project under the jurisdiction of the Triboro Bridge Authority, estimated to cost over $42 000 000.

Up to the present time, 207 construction contracts have been awarded, estimated to carry an expenditure of about $30 590 000 for public works, and rapid progress is being made in getting the entire volume of public works under way.

The National Recovery Act and Public Works Administration in Massachusetts.

BY ARTHUR D. WESTON.*

In order to assist in the operation of the National Recovery Act in Massachusetts, three acts were passed by the Massachusetts Legislature in the year 1933, viz.:

Chapter 364 — An act establishing in the Department of Public Welfare a State Board of Housing.

Chapter 365 — An act enabling the Commonwealth to secure certain benefits provided by the National Recovery Act.

Chapter 366 — An act enabling cities and towns and fire, water, light and improvement districts to secure the benefits provided by the National Industrial Recovery Act.

Chapter 364 of the Acts of 1934 establishes a State Board of Housing and authorizes that board, with the approval of the Governor, to investigate the matter of housing and building laws, encourage the creation of local planning boards, promote the formation of organizations intended to increase the number of wholesome homes and to supervise and control the operation of corporations formed for the purpose of carrying out housing projects within the meaning of the act.

Chapter 365 was enacted as it was the conviction of the Legislature that the Commonwealth of Massachusetts should:

(1) Effectively co-operate with the federal government in its policy of stimulating employment by the undertaking of an extensive program of public works;

(2) That such a program should anticipate the normal needs of the near future and should furnish a maximum of employment while involving a minmium of maintenance costs;

(3) That loans made to the states by the federal government in furtherance of such coöperation should be repaid and that therefore, without waiving any right on the part of the commonwealth to receive as favorable consideration as any other state in the event of any postponement, reduction or cancellation of payments of principal or interest upon such loans, provision should be made for such payment by the allocation thereto of a portion of certain existing revenues, with the understanding that such revenues will be released, as soon as may be, by resort to new revenues derived from such portion of the taxes and fees accruing to the commonwealth from the manufacture and sale of wines, beers and liquors following ratification of the twenty-first amendment, as is not required to meet the commonwealth's share of the cost of financing old age assistance.

For the purpose of carrying out this act an Emergency Public Works Commission (hereinafter referred to as the "Commission") was set up in the Department of the State Treasurer consisting of the Chairman of the Commission on Administration and Finance, member *ex officio;* a resident of the Commonwealth named by the President of the Senate; one such

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resident appointed by the Speaker of the House of Representatives; and two such residents appointed by the Governor. The act authorized the Commonwealth to engage in any public works project included in any "comprehensive program of public works" prepared under section two hundred and two of Title II of the National Recovery Act, but only as such project was approved by the Commission and the Governor, and in case the proper federal authorities obligated the Federal Government to make a grant for the project. For the purposes of carrying out the act, an expenditure of state funds not to exceed in the aggregate $22 000 000 was authorized. This appropriation was made with the understanding that not more than $10 000 000 should be used for road construction. The act stipulates that the construction of roads and sewers shall be done by human labor except so far as in the opinion of the state or federal office or department having charge of the project the use of machinery is "reasonably necessary" and that the wages of labor should not be less than the prevailing rate of wages as established by the Federal Government. The act also carries a provision to permit the state to borrow from the U. S. Government in the matter of projects undertaken in accordance with the act and for the issuance of bonds at such rates of interest as the State Treasurer might fix and for such terms as the Governor may recommend, but in accordance with the state constitution.

Under Section 3 of the Act, provision is made for the officers, departments, boards and commissions of the Commonwealth or groups of ten citizens to submit to the Commission their proposed projects in the form required by the Commission to be accompanied by the results of preliminary studies and general specifications sufficient for careful estimate by a competent contractor. After a public hearing and investigation the Commission is then empowered to act in the matter and if it approves it may submit the project to the Governor for his approval and then to the federal authorities for their approval.

CHAPTER 366 sets up the necessary machinery for the financing by cities and towns and fire, water, light and improvement districts through the medium of the National Industrial Recovery Act. This chapter is divided into four parts:

Part I which provides for the authority of the Emergency Finance Board in the matter of borrowing money for PWA projects by cities and towns and fire, water, light and improvement districts;

Part II relates to the construction of a subway by the city of Boston;

Part III relates to rapid transit extension outside of the city of Boston;

Part IV relates to existing structures of the Boston Elevated Railway.

The Emergency Finance Board (hereinafter to be referred to as the "Finance Board") had already been established under Section 1 of Chapter 49 of the Acts of the year 1933 to act in the matter of petitions of cities and towns to borrow money from the Commonwealth for ordinary maintenance expenses as an emergency measure providing that such borrowing is made

at any time or times prior to July 1, 1935. Said chapter 49 provides for this Finance Board to consist of the State Treasurer and the Director of the Division of Accounts as members *ex officio* and three citizens of the Commonwealth to be appointed by the Governor with the advice and approval of the Governor's Council. To assist this Finance Board, Section 1 of Part I of Chapter 366 provides that the Commissioner of Public Works, the Chairman of the Commission on Administration and Finance and the Commissioner of Corporations and Taxation shall assign such employees in their departments as the board may require under this act. Any city or town including Boston by two-thirds vote, and in the case of a city with the approval of the mayor, is authorized to engage in any public works project under Title II of the National Recovery Act provided the project is approved by the Finance Board, by the Governor and, in case a grant is authorized, by the proper federal authorities. For this purpose they are authorized to borrow from the U. S. Government such sums as may be fixed by the Finance Board, may issue bonds, notes or "other forms of written acknowledgment of debt" and for such towns and rates of interest as may be fixed by the board, provided that such borrowing does not result in the municipality exceeding its limit of indebtedness as set forth in Section 10 of Chapter 44 of the General Laws by more than one per cent. on the average of the assessors' valuation of its taxable property for the three preceding years.

The act provides that for the construction, reconstruction or resurfacing of roads and the construction of sewers the work shall be done by human labor as was the case of the act governing the state projects and that the scale of wages shall not be less than the prevailing rate established by the Federal Government. The act specifically requires that the Finance Board shall take into consideration the necessity of the project, the ability of the city or town to finance it, the extent to which the carrying out of the project will tend to relieve unemployment and the extent to which the maintenance of the project when completed will tend to increase or decrease annual expenditures and to increase or decrease the tax burden.

Work Under Chapter 364.

So far as Chapter 364 is concerned no housing corporations within the meaning of the act have been established in the state. The reason for this condition so far as I can understand is that the federal authorities have now refused to loan to such organizations and insist that municipal corporations be set up for the purpose. The work of the Chapter 364 board has therefore been chiefly promotional and in assisting municipal planning boards.

State Projects Approved Under Chapter 365.

Of the projects submitted under Chapter 365 to the state and federal authorities for consideration, 130 have been approved in Washington.

These projects represent an incurred expense of $21 544 020 or 98 per cent. of the $22 000 000 set up by the Massachusetts Legislature for this work. They include:

Hospital, school, prison, military and other building construction	$10 314 420
Highway and Bridge construction	8 762 600
Heating and refrigerator equipment, electrical power	1 301 000
Fire protection, including sprinklers and outside piping systems	744 000
Water Supply	204 000
Sewers, drains and sewage disposal	200 000
Harbor Work	18 000
	$21 544 020

Municipal Projects Approved Under Chapter 366.

Those projects which have been submitted to the Emergency Finance Board under Chapter 366 of the Acts of 1933 by municipalities and fire, water, light or improvement districts, and which have received the approval of the federal authorities are as follows:

1. Building construction, including hospitals, schools, etc.	$ 9 645 100
2. Highways, bridges, sidewalks	4 505 300
3. Drains, sewers, Sewage Disposal, etc.	4 159 247
4. Water Supply	2 962 470
5. Heating power	413 450
6. Incinerator	200 000
7. Harbor work	53 300
	$21 938 867

Experiences in Carrying Out PWA Projects.

There has been considerable delay in getting PWA projects started in this state and in order to analyze the cause of this delay I will relate the experience of the State Department of Public Health in carrying out its projects under our State PWA program. It should be stated at the start that regardless of the date of enactment of the National Recovery Act by Congress it was impracticable to initiate projects either state or municipal in this state prior to July 22, 1933, as this was the date of approval of chapters 364, 365 and 366 of the Acts of 1933, herein discussed.

On August 4, 1934, the various heads of state departments were requested by the Commission on Administration and Finance to submit a list of projects for approval under the NIRA, plans for which should be ready not later than August 31. The State Department of Public Health submitted a list of projects totaling 43 items and amounting to $102 490. This list was submitted on August 9, 1933. Of this number only four were selected as being absolutely necessary for immediate construction. Notification of this selection was received by the Department on August 21, 1933.

A hearing was given on August 23, by the State Emergency Public Works Commission relative to these projects, but notification from this State Public Works Commission that the projects had been approved by the State Engineers of the PWA was not received until March 6, 1934. I am unable to state the cause of this delay of approximately seven months, but my knowledge of the efficient manner in which the State Emergency Public Works Commission and the State PWA Engineers conducted their work would indicate that most of this delay was something over which our state officials or the State PWA Engineers had no control. From March 6, 1934, to July 10, 1934, certain additional delays were encountered, some of which are shown from the following entries in a diary kept of the progress of the work on three of these projects.

March 13, 1934, Projects advertised for first time.
March 20, 1934, Projects advertised for second time.
March 27, 1934, Bids opened.
March 28, 1934, "Standard Questionnaire and Financial Statement for Bidders" sent to three lowest bidders.
April 16, 1934, Last of forms returned by bidders.
April 17, 1934, Summary of bids and forms submitted to State Emergency Public Works Commission and recommendations made that contracts be awarded to lowest bidder.
May 11, 1934, Authorized by State Emergency Public Works Commission to award contracts on two projects to low bidder.
May 14, 1934, Authorized by State Emergency Public Works Commission to award contract on third project to low bidder.
May 22, 1934, Bonding companies on contracts approved.
June 13, 1934, Executed copies of three contracts forwarded to State Emergency Public Works Commission.
June 27, 1934, Received notification of State Emergency Public Works Commission that contractors might commence work.
June 28, 1934, Notified State Emergency Public Works Commission that work on contracts would start on June 29, July 2 and July 9 in the case of the three contracts.

The work on these projects has been expedited to the satisfaction of the State Department of Public Health in each case, and contrary to expectation the amount of the lowest bids compares favorably with the cost of similar work in the vicinity of some of these projects in the years 1929 and 1931.

Much has been said by the proponents and opponents of the PWA programs, especially as to the wisdom of such a program in the relief of unemployment. The writer does not feel qualified to express his opinion in this regard, but feels warranted in stating that so far as he can ascertain only very necessary projects have been approved for construction by the State of Massachusetts and the municipalities in this state. Assuming that these projects would have to be constructed in any case either immediately or within a period of five years it would appear to be good judgment to undertake them as PWA projects if Massachusetts were to coöperate with

the Federal Government and for the reason that the 30 per cent. grant would be the only way Massachusetts would have to salvage anything from its contribution in the form of revenue from its population to the U. S. Government, provided of course that the extra cost of the work under the PWA program did not exceed the amount of the grant. To make the program more effective all unnecessary requirements connected with these projects should be eliminated.

I would like to present a few figures because they emphasize the financial condition of this state and in my opinion more or less decide the policy of unemployment relief regardless of our personal opinions.

In 1929 there was spent in the Commonwealth of Massachusetts for welfare $13 281 000; in 1932 this figure had reached $41 792 000; we are advised that the 1933 figure was higher than that of 1932, and that the 1934 figure will be even greater than that of 1933.

When one realizes that real estate and personal property are the principle sources of our revenue system and that the valuation of real estate and tangible personal property was $7 233 539 128 in 1930, shrinking to $7 181 358 958 in 1931; to $7 001 697 802 in 1932; and to $6 741 000 000 in 1933, and that there was levied in 1932 as a State Tax about $9 750 000, as a County Tax $11 638 145, both of which in large part must be met by taxes flowing from real estate and personal property, and for municipal purposes $220 844 423, or a total of $242 232 568; I think you will agree that we must have some other base of relief for welfare work than taxation on real estate and tangible property. While I am not advocating the PWA, the CWA, or the FERA or any other forms of federal relief, I do feel that those programs come the nearest to allocating relief costs in some other manner than a direct assessment on real estate even though it may be more nearly an assessment on income. Real estate and tangible personal property should be selected for public welfare costs no more than any other source, and as a practical matter would not be but for the ease of collecting from such a source.

General Discussion.

Mr. Barbour. The subject is now open for general discussion. There should be a number of men who desire to testify.

I had intended to make a brief statement, but what I had to say has been much better said by Mr. Shaw. I think that one of the most important conditions referred to by him is that of the relative cost of work done under PWA control and under normal contract requirements. I personally believe that on water and sewerage work contracted for under PWA auspices in New England during the next six months, the extra cost chargeable to PWA regulations will exceed the average federal grant of 25 per cent. I say this as a result of contacts with quite a number of contractors who have had experience in one or more PWA jobs. I believe this condition is not so much due to the wage scale or to the thirty-hour week as to the stipulation that labor shall be obtained from the list of "qualified" workers submitted by local employment agencies designated by the United States Employment Service. The situation turns on the interpretation of "qualified" and on the time necessary to try out the labor, and particularly the keymen offered to the contractor. My experience indicates the effect to be such delay in efficiently organizing the work that the morale of the job is disrupted and costs are increased to a degree that one experience convinces the contractor of the necessity of a substantial increase in prices to cover PWA requirements. It is true that special dispensations are being granted for the bringing in of keymen — but generally after costly trial of the employment service list — and in some cases the continued imposition of incompetents has greatly increased costs to the contractor. It would seem that a definite statement in the notice to bidders of the contractor's right to bring on the work a specified number of the keymen of his organization could profitably be made without seriously affecting the local reëmployment problem — all of which discussion suggests the question as to whether the basic objective of the PWA was the stimulation of business or the relief of unemployment — even to the point of inefficient keying of the job.

If, as I believe, PWA requirements increase contract prices in municipal work by a percentage at least equal to that of the grant, another broad question arises — in the light of the present inability of the taxpayer to meet his obligations — as to the justification for the undertaking of improvements beyond those absolutely necessary, under governmental regulations which permit practically unlimited use of machinery and are not directly aimed at the reëmployment of local labor.

A condition of particular interest to the practising engineer is that of the attitude of the PWA in reference to the specifying of special equipment which the engineer acting for the municipality believes necessary for carrying out his design. Is he to be permitted to specify directly the equipment he desires to obtain, or must he write a specification that will provide

competition and run the risk of PWA insistance on the acceptance of the lowest bid?

MR. BARBOUR. I am going to ask Mr. Lockwood to comment on this question of requiring competition in the specifying of equipment. To illustrate — assuming that an Imhoff-tank, trickling filter sewage-treatment plant has been designed — the layout of the distribution system and nozzles requires the use of particular equipment and nothing else is possible without substantial redesign of structures. Surely there should be sufficient decentralization of authority to permit men of the calibre of our State PWA Engineers to exercise their judgment in setting aside — without danger of backfire from Washington — of the requirement of competition, which is primarily based on the suspicion that specifications of particular equipment or material are founded on some other motive than a desire to obtain that best adapted to the requirements of the design.

It is this same suspicion of motive which is responsible for much of the PWA time-wasting procedure and the delay in getting work promptly into construction, and a recent opportunity of visiting some of the economically indefensible major projects — fully financed by the PWA — suggests that such super-scrutiny of the small municipal projects is all out of scale.

MR. LOCKWOOD. I think the fundamental point back of the specification problem, in this so-called specialization of equipment, is that the Government must of necessity, whenever it contributes any money, keep everything as open as possible to all citizens.

As a direct illustration: if, in his specifications, the architect or engineer has specialized on equipment, it means that you immediately get the men who are, we will not say direct competitors, but who may be close competitors, or who may in their opinion have an equipment which is as good as the other fellow's, and naturally if they are left out there is great complaint. Naturally, these protests have considerable weight among those who are concerned with these projects, both in the state office and in Washington, and there is tremendous pressure brought to bear. But I think Mr. Barbour is correct in the sense that the appropriation involved should govern the situation.

I am not telling any secret if I tell of a particular case in which Mr. Barbour was interested. It seemed to me that in the design, Mr. Barbour, from his experience, was far better equipped to tell what the design and specifications should be, than I. Naturally, I would listen to what he had to say about it and try to follow his desires, since he represented the borrower, as far as it was humanly possible to do. But, immediately we do that, there is a complaint from somebody that is going to Washington because his equipment is left out. You get that back pressure, and that causes many of the officials to hesitate to make decisions. But I have made my plea entirely on the basis that the amount involved by some of these special equipments was such a small per cent. of the total job that, since you put the total job into the competitive field, certainly you ought to have a little

leeway as to what might be competitive and what not. But I think it is essentially a governmental reaction that, whenever federal money is used or federal people are concerned with it, many are afraid to take the responsibility. That is the essential part of it. In many cases — and I do not say this in an egotistical sense at all — I have made decisions, and if I had been a particularly prayerful man I would have spent many hours in praying that I might be backed up. But that is a serious part of it. I can take a certain amount of responsibility, but I don't know whether my superiors in Washington are going to back me up or not. There is where the difficulty arises.

I do not like to contradict the Chairman, but it is set up in the contract that a contractor can bring in key men. The extent of the key men in the past, I will admit, has been somewhat overstressed by the state engineers, because we have been faced with the problem from both sides. "We are in our own local bailiwick, and if you do not get the employment situation helped out, or if we do not play pretty good ball with our local people, that is not going to go too well." At the same time, if we do not do our job from the Washington point of view, that is not going to go any too well either. So that you see we are between the devil and the deep sea in many of these troubles, and we can't change it. I do not offer that as an excuse, but I do say that in many instances the state engineers may have gone a little too far in stating how many key men or what key men you could bring in. But you were always faced by the problem, when you went out to sell that job originally, that your local fellows wanted local men, and you had to pretty well promise them that they could use their local help. Then you turn around and you have to satisfy the other fellow, and you will bring in as many as you dare let come in. You have to set a limit, which is pretty tough. When we have been shown that the local help was not qualified, or that the contractor needed more key men, we have tried in every instance to meet the demand.

I agree with Mr. Barbour that the time consumed may have been longer than necessary, but once again it is that problem that the state engineer always faces,— just how far he can go and be backed up. Any government official, if he bumps his head a good many times, sits back and won't assume the responsibility. If in the future we can get a little better decentralization, a little better clarity as to how far the state engineer can go, many of these details can be very quickly and easily solved.

The question of the price increase in contracts we have not noticed particularly, and that is probably because we are up in the "sticks." Just last week we had nine bidders on a small bridge. The State of Vermont had coöperated with us in fifteen highway bridges, and there were three bridges built by state aid and not under our jurisdiction, but they were right in the same localities and bid on by the same companies. I only found a 15 per cent. increase in the PWA bids over the bids under non-PWA work. That is just local, although I am afraid that unless something is done to offset

that tendency we may find contractors jumping their prices. That is a thing which might be handled by a change in the amount of the grant or in the way in which the grant may be figured. Those are policies which will have to be worked out, naturally, by the administration itself. That is not up to us. I might be able to recommend it, but it is not up to us to decide. There may be other ways of figuring this out, and I am sure that every effort will be made to do it.

Let me illustrate one particular case that involves procedure, because, as far as the Government goes, from my experience it does not make any difference whether it is one cent or $10 000 000. I came down to Boston one day for a meeting of our regional district, which we had in the beginning, and I had expected to go from Boston either to Washington, or Portland, about matters concerning the office we have there. I bought a one-way ticket, because I had expected to go from Boston right to some other point. For some reason, something happened, and the Concord office called me, and I had to go back to Concord that night and continue the journey the next day; I bought another one-way ticket. Seven months later I got a notice from the Comptroller General that I owed some 88 cents because I had bought on the same day a ticket to Boston and then a ticket returning from Boston, whereas I should have bought a roundtrip ticket and saved the Government 88 cents. You are familiar with the detail, but that is the point. It doesn't make any difference from the Government's side of it whether it is 88 cents or $10 000 000; 88 cents is just as important. It is much of that kind of procedure which has placed us in the position in which we now are.

I think that is just as true with regard to specifications, or any of those things. You are faced with the fundamental problem, the minute you have Federal money involved, of keeping things open so that everybody participates in it, because it is more or less everybody's money. I mentioned in my talk previously that I thought that was rather a hardship on the local communities, and I still think so. I talked last night for a couple of hours with one of the legal advisers from Washington, trying to work out ways to circumnavigate some of these things, but immediately some legal phase of it bobs up and indicates that it is a nice idea but impossible. Under the Act, it can't be done.

You will find so many times that, with the best intention, a law is drawn up such as even the Industrial Recovery Act. As a particular case, no provision was made in the National Industrial Recovery Act for the hiring or buying of automobiles. Somebody forgot it. It was necessary to get an executive order. They wanted to use the PWA money which was turned over to the different departments, but when it came to the Comptroller General it was impossible, he would not allow it. Those are things which we must bear in mind whenever we are dealing with governmental operation.

MR. WARREN J. SCOTT. I would like to ask one of the state engineers, if the Federal policies toward extension of the PWA and FERA activities continue, isn't it likely that the FERA is going to force the PWA out of the field, so to speak, in public interest so far as small projects are concerned?

MR. LOCKWOOD. I think it should, sir, and I think I expressed that view earlier. I think that under our present conditions the public works division should not be saddled with small jobs. I say that with great feeling, because I come from small states. Where Massachusetts and New York talk about twenty-nine million, we just divide by ten, or something like that. I have, as a matter of fact, almost as many projects in the three states as Massachusetts has in operation today, but mine are scattered over quite some territory. It takes twenty-four hours to get from the Portland office to one of our jobs. We are scattered, and we have a lot of little jobs. But as I say, it takes just as much paper work, just as much of every kind of thing you can think of and it takes just as much work for our office to handle a four thousand dollar job as it does a million dollar job, and I speak of that from experience. I think that, as I mentioned earlier, there should be somewhat of a classification of work and that it should be subdivided properly because a most serious thing, to my mind, is that later on the community is going to say, "Why, Mr. Town Father, if you had been wise you would have done that job by CWA and saved money; you did it by PWA and it cost us more." That applies any way you look at it.

Your program faces a serious situation, and that is why I think we should have a coördination of all these divisions, and we should have guidance. The situation should not crop up wherein the FERA fellow is trying to steal our job or we are trying to steal his, or anything else of that kind. I think we should have a coördinated system so that if a man or a town or anybody else wants to get government aid of one sort or another, whether it is a state or a community or whatever it is, he could know pretty well to which organization he should apply and where he should go to get that aid, and the class of aid which he should receive. I think it is very necessary to do that.

Originally, all this procedure was started right off and we were expected to function as a 100 per cent. business organization, not knowing even half the clerks in the office. It is pretty tough and we could not do it very successfully. We were asked to become a 100 per cent. organization overnight, and it just could not be done. But I think we can iron out these matters in the future.

MR. SHAW. One of the things that is confusing contractors is the great lack of uniformity in policy of the local reëmployment managers in the different cities and towns in connection with the matter of key men. We have had one instance where a contractor was able to go to the employment manager the first day he came on the job and arrange to bring in certain key men — his steam shovel operator, foreman, and so on — by the very simple formality of bringing those men to his office and registering

them. We have had another case where a contractor has been made to wait a week or ten days while the manager made fruitless search in ever widening circles through his territory, to find a certain key man, and at the end of that time he said, "Well, I can't find him; you may bring your own man in." In the meantime the job, or a section of it, was held up. A contractor cannot be certain in advance of making his bid just what the policy is going to be. In this particular a little more centralization would help by putting all employment offices on the same basis.

ROBERT SPURR WESTON.* I think it is unfortunate in connection with the lack of freedom of choice of equipment by the engineer, that he is held responsible for the work for a long time, while the agency in Washington, which may overrule his choice, will be forgotten. As you enter any water-works structure you probably see on the brass plate beyond the door the engineer's name. If he has to accept inferior equipment, particularly things like meters and valves, to be sworn at for ten years by the superintendent, he has to suffer for it. I therefore think it is very important that Mr. Lockwood's suggestion of decentralization be carried out to as great a degree as practicable.

MR. LOCKWOOD. I think I am correct in making this interpretation, because we have applied it several times. If the town or the city has an existing water system to which the work which is done under PWA is an extension, or something to that effect, and if they have been using certain standard equipment, such as hydrants, meters, and so on, which are considered by them the best and have adequately served them in the past, we do entertain the desire on the part of the town to use the same type of equipment, and unless the cost is way out of line we have recommended that and have had it go through. I am pretty sure that in the case of one or two of our towns, where they had existing water systems and had used certain types of equipment, we have done that. There is where your difficulty did not come in. I do not know how far you can go in that direction. I have been fairly fortunate so far in making such decisions and being backed up in them. I can't talk for other states, but with me that was the case. I have tried to use, so far as I could, good judgment, and in most cases I have been backed up. But that does not mean I am going to continue to be backed up, necessarily.

In regard to the reëmployment problem, I know that the reëmployment service, like all the other branches, grew up overnight, and that they did not have sufficient funds to allow the reëmployment man in charge of the district to really find out about his situation. I think that was part of the trouble, — they did not have the funds to go around and investigate the men who were on their list, and therefore they did have to take more or less the word of the man as he came in. If he was out of a job and had never wielded a paint brush, he would say he was a painter. That is only natural. Those fellows were in a pretty tough spot. We did not have the time or

*Consulting Engineer, Boston, Mass.

money to go out and find out what those fellows were. But I think that can be taken care of. In one of our states where I found the reëmployment man was not on his job and incapable, I simply had the fellow looked up and submitted the facts to the reëmployment director of the state and said, "This fellow is no good; you will have to get a better man," and we had a new man.

MR. BARBOUR. The suggestion I made was that if, depending on the size of the job, the contractor could be advised in advance that he would have the right to bring in a certain number of his own organization, that one setup would influence the attitude of the contractor on costs more than any other one thing.

MR. LOCKWOOD. That is true.

MR. BARBOUR. Mr. Taylor, what about the situation in New Bedford?

STEPHEN H. TAYLOR.* Our job in New Bedford is going along satisfactorily. There was a lot more red tape than we are used to, or enjoy, but I think, all things considered, we can say that our relations with the state engineer have been very satisfactory. I do not know how much more the job has cost than it would if we had not done the work under PWA. I have no way of knowing. But taking into consideration our own agony through the necessity of filling out all of these blanks and following the requirements, plus whatever more we might pay the contractor on account of PWA requirements, it seems to me that, if the city can raise its own funds and go ahead in its own way, perhaps it would be better off. But I do think that the PWA fills in a gap where perhaps the city can't raise its own funds.

MR. BARBOUR. I am sure that we are greatly indebted to Mr. Lockwood for his very frank discussion of this subject and his courtesy in answering these questions.

*Superintendent of Water Works, New Bedford, Mass.

IMPROVEMENT OF THE WATER SUPPLY OF BRAINTREE, MASS.

[*Read September 19, 1934.*]

BY ROBERT SPURR WESTON.*

For many years the quality of the water supplied from Great Pond to Braintree, and to Randolph and Holbrook was of poor quality and the subject of comment and report. Besides reports by the Massachusetts Department of Public Health, there have been those of the late William Wheeler, dated February 24, 1903, of Symonds and Stevens, dated January 25, 1921, and others. The works now in operation, and described in this paper, followed a report made by Weston & Sampson on January 30, 1933, and action by the Town of Braintree at its March meeting of that year.

Treatment of the water was urgently needed, not only because of the poor appearance of the water, but also because of the rapid increase in population and attendant pollution on the catchment area. The town is now faced with the problem of augmenting the supply.

Quality of Great Pond Water. The water of Great Pond is highly colored, possesses an objectionable odor and taste and is gathered from a highly-polluted, unsewered catchment area. A large part of the area lies beyond the borders of the Town of Braintree. On November 30, 1932, the water had the composition shown in Table 1.

TABLE 1.— COMPOSITION OF GREAT POND WATER, NOVEMBER 30, 1932.

Determination.	Parts per Million.
Odor (cold)	3 Veg.-Arom.*
Odor (hot)	3 Veg.-Arom.*
Turbidity	1.
Color	60.
Oxygen Consumed	9.7
Nitrogen as Free Ammonia	0.038
Nitrogen as Albuminoid Ammonia	0.192
Nitrogen as Nitrites	0.003
Nitrogen as Nitrates	0.180
Chlorides	8.5
Alkalinity	9.0
Hardness	15.6
pH value	6.2*
Iron	0.29
Residue on evaporation	72.
Mineral residue	25.

* These values are not expressed in p.p.m.

The color of the water, for the past few years, has ranged between 8 and 60 and has averaged 36 p.p.m., in former years and in 1934 it has been

* Of Weston & Sampson, Engineers, Boston, Mass.

even higher. The color value may be contrasted with that of Silver Lake water which is supplied to Brockton with a color of 9 p.p.m., or to that supplied by the Metropolitan Works to Quincy with a color of 14 p.p.m. The color is due to vegetable matter. This is objectionable, not only on its own account but also because chlorination of the water in accordance with necessary practice forms a compound having a disagreeable odor which is especially noticeable when hot water is drawn from the taps.

Great Pond water is visited at times by growths of microscopic organisms which impart a decided musty-aromatic taste to the water. These growths were particularly abundant in 1928 and 1930.

The permanent population of the catchment area, particularly in Randolph east of highway No. 28 (Randolph Avenue) and along the feeders of Great Pond, is growing rapidly and the population density now amounts to about 700 per square mile. This is the highest value for any unsewered catchment area in the state and well beyond satisfactory limits for water protected by storage and chlorination alone. In summer the population on the watershed is increased by summer residents. Since most of the area lies beyond its own borders, Braintree has to depend upon another town to enforce sanitary regulations.

Insanitary conditions menacing to the Great Pond supply were the subject of several reports to the Town of Randolph by the State Department of Public Health, notably the report of 1926 in which purification of the water or collection and treatment of the sewage from the areas west of the pond was recommended. It is also true that for several years, notably in its reports of May 7, 1903, and of July 19, 1911, the Department has advised the purification of Great Pond water.

Some of the sanitary conditions upon which the State Department of Public Health has reported to Randolph are bad. For example, some of the house lots along the feeder brooks of the pond are so small that sanitary conveniences may not be located at a proper distance from the brook and still be on the property of the owner. Cesspools and privies drain into the feeders. Many of the buildings are of low grade construction, designed for summer occupancy only, but on account of the depression they have been continued in use throughout the year. They are increasing in number rapidly and at this writing conditions call for prompt correction.

To determine the kind of treatment required, careful experiments were made in the laboratory. Slow filters, with or without chemical treatment, and rapid filters with chemical treatment, such as are commmonly used to purify colored surface water were considered, and rapid filters with chemical treatment were shown to provide the best method of purifying Great Pond water.

Odors and Tastes. It was realized that while aëration would remove the odors due to algae, it would not free the water from the musty-vegetable or "swamp tea" taste due to dissolved vegetable matter. This taste is one of the most disagreeable characteristics of Great Pond water. To remove

it, the water must be treated with activated carbon which adsorbs the odor.

In advising on the proper treatment for the water, reduction of its corrosive action upon the distribution system by treatment with alkali was recommended.

While the works as constructed and operated produce a safe water, a small dose of chlorine furnishes an additional safeguard.

Methods of Treatment. The general method of treating the water after pumping from Great Pond includes the following steps:

(1) Addition of sulphate of alumina, with, at times, sodium aluminate, to the raw water, with thorough mixing.
(2) Addition of activated carbon to adsorb the disagreeable odors and facilitate coagulation.
(3) Slow stirring for 15 minutes to coagulate the water.
(4) Storage of the treated water in a coagulating basin for 3 hours to perfect preliminary treatment.
(5) Filtration through rapid sand-filters to remove the coagulated coloring matter and chemicals.
(6) Treatment with alkali to prevent corrosion.
(7) Application of a small dose of chlorine.
(8) Storage in a filtered water basin from which the high-life pumps take their supply.

Additional Supply. Three towns share the privilege of taking water from Great Pond, and the proper relations among them were best described by Mr. Wheeler. "If the use of the waters of Great Pond be shared in common by the Towns of Braintree, Randolph and Holbrook upon the bases and to the full extent of their several needs and of their opportunities for the proper use and enjoyment thereof, respectively, without infringing or menacing the equal rights and enjoyments of others therein, then the supply available in and at the disposal of each of the said towns can be limited and determined only by its proper use and nature thereof *until* such time as the combined uses and requirements of all of them should exceed the supplying capacity of the pond."

The joint use of the pond by the three towns and the fact that Braintree is increasing its water consumption more rapidly than the other towns raises the problem of increasing the supply. In this connection, data referring to population and water consumption will be of interest.

Population and Water Consumption. Comparison of various estimates of population shows that the population of Braintree is increasing more rapidly than estimated in the past. This is true also of the water consumption, and both statements apply equally well to the northern part of Randolph, but not to Holbrook.

The estimates are presented in Table 2.

Evidently the present consumption by Braintree, which in 1932 was 891 000 g.p.d., is much higher than estimated by Messrs. Symonds and Stevens for domestic consumption alone and not much lower than the

TABLE 2.— POPULATION AND WATER CONSUMPTION OF BRAINTREE, 1880–1960.

YEAR.	BY WILLIAM WHEELER. 1903		BY SYMONDS & STEVENS. 1921		PRESENT ESTIMATE.	
	Population.	Consumption g.p.d.	Population.	Consumption g.p.d.	Population.	Consumption g.p.d.
1880	3 855*	....	3 855*	....	3 855*	....
1885	4 040*	....	4 040*	....	4 040*	....
1890	4 848*	....	4 848*	....	4 848*	....
1895	5 311*	307 741‡	5 311*	....	5 311*	307 741‡
1900	5 981*	543 603‡	5 981*	....	5 981*	543 603‡
1905	....	....	6 879*	....	6 879*	600 000‡
1910	7 476#	598 000#	8 066*	....	8 066*	653 000‡
1915	....	....	9 343*	....	9 343*	498 000‡
1920	9 345#	747 600#	10 544#	474 500†#	10 580*	742 000‡
1925	....	....	12 126#	545 700†#	13 193*	939 000‡
1930	11 681#	934 480#	13 709#	616 900†#	15 712*	1 313 000‡
1935	....	....	15 766#	709 500†#	18 500#	1 112 000†#
1940	14 601#	1 168 080#	17 822#	802 000†#	21 100#	1 372 000†#
1950	18 251#	1 460 080#	20 496#	922 300†#	26 500#	1 722 000†#
1960	22 814#	1 825 120#	23 169#	1 042 600†‡	31 900#	2 073 000†#

* Census.
# Estimated by projection.
‡ Measured.
† Domestic only.

TABLE 3.— POPULATION AND WATER CONSUMPTION OF BRAINTREE AND OF RANDOLPH-HOLBROOK, 1920–1960.

YEAR.	BRAINTREE.		RANDOLPH-HOLBROOK.		THREE TOWNS.	
	Population.	Water Consumption g.p.d.	Population.	Water Consumption g.p.d.	Population.	Water Consumption g.p.d.
1920	10 580*	742 000‡	7 917*	531 000‡	18 497*	1 273 000‡
1925	13 193*	939 000‡	8 917*	509 000‡	22 110*	1 448 000‡
1930	15 712*	1 313 000‡	9 906*	634 000‡	25 618*	1 947 000‡
1935	18 400#	1 112 000†#	10 970#	713 000†#	29 370#	1 835 000†#
1940	21 100#	1 372 000†#	12 020#	781 000†#	33 120#	2 153 000†#
1945	23 800#	1 547 000†#	13 080#	850 000†#	36 880#	2 397 000†#
1950	26 500#	1 722 000†#	14 130#	918 000†#	40 630#	2 640 000†#
1955	29 200#	1 898 000†#	15 190#	987 000†#	44 390#	2 885 000†#
1960	31 900#	2 073 000†#	16 250#	1 057 000†#	48 150#	3 130 000†#

* Census.
# Estimated by projection.
‡ Measured.
† Domestic only.

combined domestic and commercial consumptions estimated by Mr. Wheeler. In 1932 the commercial consumption was 364 000 g.p.d.

The present estimates of future population and water consumption by Randolph and Holbrook likewise exceed the earlier ones. They are shown in Table 3.

The yield of Great Pond, with high water at the reference mark[1] and the water drawn down 8 ft. has been previously estimated as 2 161 000

[1] Drill hole at the dam.

g.p.d. by William Wheeler and as 1 750 000 g.p.d. by Symonds and Stevens. These estimates were made before the dry year of 1930. With more recent rainfall records available, it is now estimated that the present minimum safe yield of Great Pond, with high water at the drill hole* and assuming the pond to be drawn down 6 ft., is 1 495 000 g.p.d. The amount of water available from Great Pond during a dry period may be increased by providing additional storage capacity. The limit of safe yield may be based on the records of a drouth extending over several years during which the reservoir will at no time be refilled by floods. Such a drouth began on June 1, 1908, and ended on November 1, 1911, a period of 1248 days. Table 4 gives the storage capacities of Great Pond at various high-water levels and the corresponding yields for the 1908–1911 drouth with the pond drawn down 6 ft. below the present high-water level.

TABLE 4.— CAPACITY AND YIELD OF GREAT POND.

High-Water Level.	Storage Available m.g.	YIELD — GALLONS PER DAY.	
		Total.	Increase over Present.
118.16 (Present)	271	1 495 000	.....
120.16 (Raised 2 ft.)	424	1 825 000	330 000
122.16 (Raised 4 ft.)	606	2 085 000	590 000
124.16 (Raised 6 ft.)	807	2 250 000	755 000
126.16 (Raised 8 ft.)	945	2 360 000	865 000

TABLE 5.— AREA OF WATER SURFACE OF GREAT POND.

Water Level.	WATER SURFACE — ACRES.		Percentage Increase.
	Total.	Increase Over Present.	
118.16 (Present)	205	—	0
120.16 (Raised 2 ft.)	265	60	29
122.16 (Raised 4 ft.)	295	90	44
124.16 (Raised 6 ft.)	318	113	55
126.16 (Raised 8 ft.)	335	130	63

While it is probably true that the yield for a single dry year would exceed the figures in Table 4, on account of the infiltration of ground water into the pond as the water was drawn down, this benefit would be slight at the end of an extended drouth and has been neglected in the values given.

Table 5 gives the area of water surface for Great Pond at various levels above present high water.

The height to which it is advisable to raise the water level of Great Pond is contingent upon the increase in yield thereby provided, the cost of the undertaking, its influence on the quality of the water, the effects of the flooding on adjacent property, especially on the pumping stations, and other considerations.

*Drill hole at the dam.

After careful study it was found that 4 ft. above the present high water —elevation 122.16 on William Wheeler's base—is the practicable limit of raising the water level. With this additional storage the yield of Great Pond, even during a drouth extending over four years and as severe as any yet recorded, would be increased by 590 000 g.p.d. to a total of 2 085 000 g.p.d. It is estimated that this minimum yield would supply the towns of Braintree, Randolph and Holbrook with water until the year 1940, even if that year should happen to lie at the end of a four-year drouth comparable to that of 1908-1911. This coincidence is extremely unlikely and it is believed that one could reasonably expect this supply to serve until 1945 or even 1950. At any rate the towns would have ample time during the last two years of the drouth to provide an auxiliary source. For a year of average rainfall and runoff the present yield of Great Pond is estimated to be 2 940 000 g.p.d., and with the increased storage, 3 530 000 g.p.d., sufficient until the years of 1956 and 1968, respectively.

Ground-water Sources. On several occasions, searches for ground water have been made. These included tests of certain areas by the writer's firm.

While it is possible and quite likely that further investigation will disclose one or more ground-water sources that warrant development, and while the possibilities of this investigation should be studied before the domestic consumption equals the yield of Great Pond, that is before 1940, there are many difficulties in this direction due to the low yield of the ground where the catchment areas are ample, and the smallness of the catchment areas where the rates of yield are highest.

Water Purification Plant.

The accompanying plan (Fig.1) shows the general arrangement and connections of the new water-purification plant with the existing pumping station.

The principal structures are:

(1) Low lift pump room with pumps and accessories.
(2) Filter house with chemical-storage room, chemical feeders, mixing tank, rapid filters and filter piping and appurtenances.
(3) Coagulating basin.
(4) Wash-water tank.
(5) Filtered-water basin.
(6) Settling basin.

Pumping Equipment. Connection for supplying water to the new plant is made with the existing 16-in. intake in Great Pond. In an addition to the old pump room (26.5 by 12.5 ft.) there are provided:

(1) A single-stage, double-suction centrifugal pump for raw water, directly connected through a flexible coupling at one end to a 25-h.p. electric motor, and at the other end to a 35-h.p. 1 200-r.p.m. internal combustion gasoline engine. The unit is designed for a rate of 1 400 g.p.m. against a head of 35 ft.

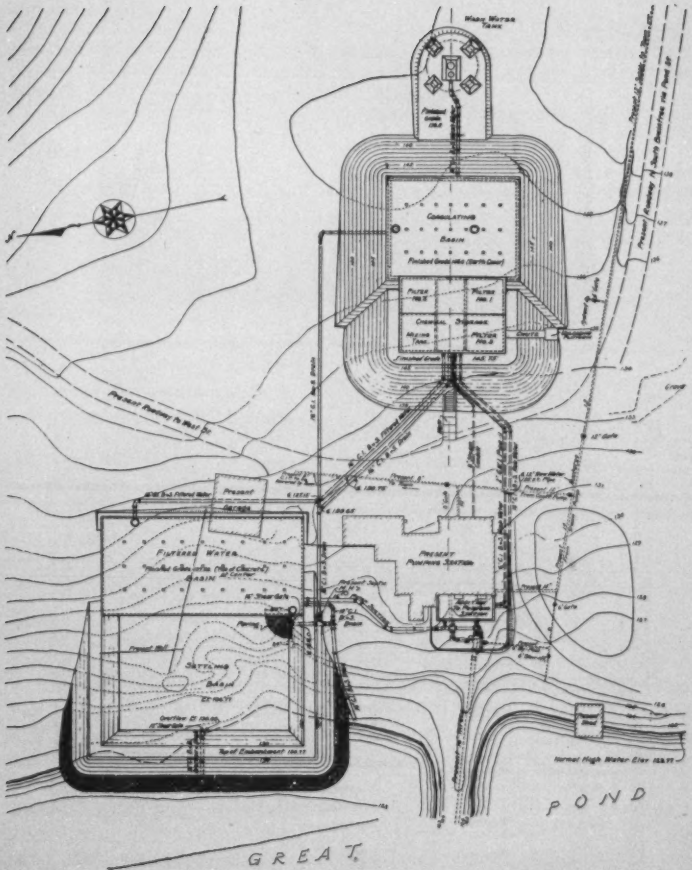

FIG. 1.— GENERAL PLAN OF BRAINTREE WATER PURIFICATION PLANT.

FIG. 2.— FILTER HOUSE.

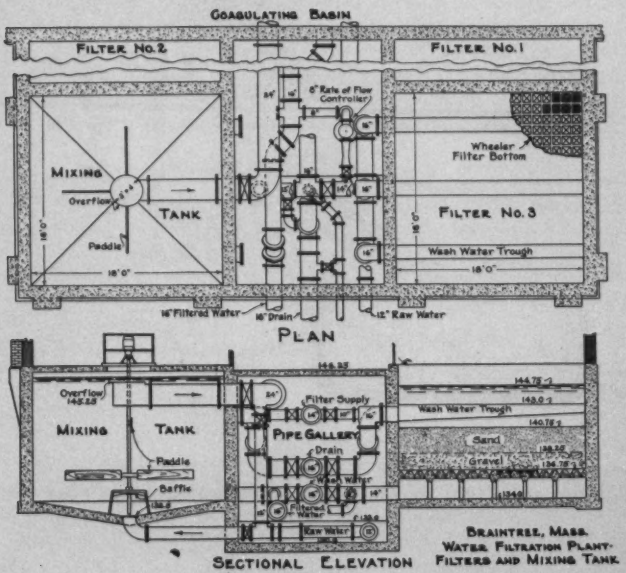

FIG. 3.— MIXING TANK, FILTERS AND CONNECTIONS.

(2) A wash-water pump of the same type with a 10-h.p. motor designed for 400 g.p.m. against a dynamic head of 60 ft.

(3) An automatic priming system connected with the existing one at the station with the addition of a vacuum tank and connections.

(4) A 3-panel switchboard with the usual controls and gages, including automatic vacuum and pressure switches for the vacuum and wash-water pumps. The current is 3-phase, 60-cycle, 220-volt and is furnished by the Electric Light Company of Braintree.

(5) Piping, valves, gasoline storage and other appurtenances.

The raw-water pump discharges through a 12-in. main located in the filter house.

Mixing Tank. The mixing tank is 18 ft. square and has an average depth of 14 ft. It stores at least 15-minutes of flow. Water enters at the bottom of the mixing tank, meeting there a deflecting plate above which is

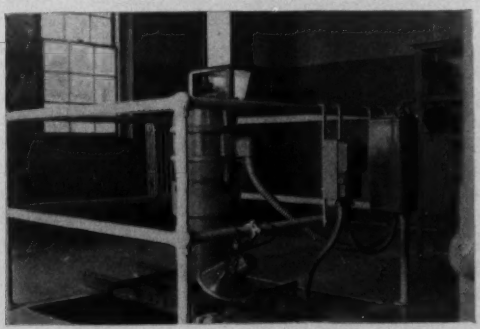

FIG. 4.— MIXER DRIVE AND CHEMICAL FEEDERS.

a revolving paddle attached to a central, vertical shaft driven at rates of from 2 to 4 r.p.m. by a 2-h.p. motor and reducing gear coupled to the other end of the shaft in the room above. Water overflows a central circular weir at the top of the mixing tank connected with the 24-in. main leading to the coagulating Basin (See Figs. 3 and 4).

Coagulating Basin. The coagulating basin is a rectangular structure provided with inlet, outlet, baffles and drain and discharges through a 14-in. main to the three branches in the filter gallery connected with the filters. The design provides a minimal storage period of 3 hours.

Filters. Each of the three filters is 18 ft. square. Instead of using the customary central underdrain with laterals, a chamber 2 ft. deep, with manhole for access, was constructed beneath each filter bottom, upon which are placed the pyramids with 3-in. spheres and smaller marbles of the Wheeler filter bottom, each provided with a ¾-in. outlet tube. This design follows in general the one for the Mahoning Valley water purification plant, by G. Gale Dixon.[1] See Figure 3.

Above the Wheeler bottom are four layers of graded gravel, 18-in. in total depth, and a layer of sand, 2.5 ft. deep, having an effective size of 0.45 to 0.50 mm. and a uniformity coefficient not over 1.6. Each filter is provided with three wash-water troughs of copperized steel, 16-in. in width by 19-in. in depth at the outlet end, and 11-in. in depth at the inlet end where adjustable supports are provided.

Wash-water is supplied from a tower tank of the railway type having a capacity of 75 000 gal. and located to the east of the coagulating basin. Water for washing filters is brought through the filter gallery in a 16-in. wash-water main with 14-in. branches to the water spaces beneath the filters. The filters discharge through Simplex controllers to the 16-in. effluent main leading to the filtered-water basin.

All the valves are operated hydraulically and controlled from operating tables made by the International Filter Company. On the tables are also the rate-of-flow and loss-of-head gages and the valve wheels for regulating the filter controllers. Above each filter is a high-powered adjustable light controlled by a switch at its respective operating table.

Devices for Applying Chemicals. Storage for chemicals is provided in the second story of the filter house located across the road and east of the pumping station. At one end of the building is a receiving platform from which chemicals are hoisted through a door at the southerly end of the storage room by means of an electric hoist, hung on a mono-rail for distributing the chemicals within the room. At the other end of the room are platform scales for weighing, and the four screened openings leading through hoppers to four Bacharach chemical feeders on the floor over the mixing tank below. From this floor stairs ascend to the storage room. Three of the feeders, those feeding sulphate of alumina, sodium aluminate and activated carbon, discharge through solution tanks and connecting piping to the raw-water main. The fourth feeds alkali to the filter-effluent main.

A fine balance is provided for rating the feeders.

Filtered-Water Basin. The effluent-main discharges into the filtered-water basin located across the road to the north of the pumping station and near Great Pond. This basin is of concrete, 100 by 50 ft. in area, and provides for a depth of water of 13.5 ft. It stores 500 000 gal. A 16-in. suction main connects the filtered-water basin with the suction of the high-lift pumps in the station nearby.

Settling Basin for Waste Wash-water. It was considered inadvisable to discharge waste wash-waters into the pond directly, and the cost of a drain to the outlet was prohibitive. Consequently, a settling basin 60 by 86 ft. and 4 ft. deep, with earthen embankments, was provided.

This basin has an underdrain bottom of clean sand 12-in. deep, an inlet with paved quadrant to reduce scour due to entering water, and an overflow and drain leading to the pond. The overflow is in the form of a funnel-shaped circular weir. The way to the drain is through an 8-in. shear gate

provided with a handle. The basin is to receive the drainage from the coagulating basin as well as the waste wash-waters.

Chlorinator. A small dose of chlorine is applied to the water delivered to the mains by a Wallace & Tiernan vacuum chlorinator located in the same room with the high-lift pumps.

Plant Control. At the far end of the filter house is a laboratory table with sink and connections. (See Fig. 5). This is furnished with apparatus for determining color, odor, alkalinity, pH value and free chlorine; also, for making jar tests to determine proper dosage of chemicals. The colorimeter somewhat resembles the one at Indianapolis described by Harry E.

FIG. 5.— OPERATING FLOOR.

Jordan.[2] The apparatus for determining pH value was manufactured by the W. A. Taylor Company of Baltimore. The colorimeter and apparatus for determining free chlorine were made in the laboratory of the writer's firm.

In the filter house near the laboratory table are located the sampling devices, with glass vessels for observing the appearance of raw and filtered water at all times, and also the wash-water-pressure gage and the attendant's desk.

Operation. The plant was placed in service on May 16, 1934. At the beginning, the color of the raw water was unusually high, averaging about 100 p.p.m. With the drawing down of Great Pond the color has fallen to about 35 p.p.m. At first both sulphate of alumina and sodium aluminate were applied to the raw water together with activated carbon. Recently the aluminate has been omitted and the dose of carbon reduced.

The results of operation have been satisfactory. Particularly good has been the action of the filters, their washing especially. This is believed to be due to the hydraulic excellence of the double filter bottom as compared with the arrangement of piping usually employed in the Wheeler filter bottom.

Also satisfactory has been the operation of the mixing tank. Good coagulation has been produced at the end of the 15-minute period at all times, the water passing to the coagulating basin and there depositing an unusually large percentage of suspended matter.

The quality of the water supplied to consumers has been high, the change from one of the most disagreeable waters in Massachusetts being

TABLE 6.— PERFORMANCE OF WATER-PURIFICATION PLANT.
(September 17, 1934).

Determination.	Great Pond.	Mixing Tank.	Filter Effluent.	Station Tap.
Odor (cold), 20° C.	2 veg.	2 veg.	None	None
Odor (hot), 90° C.	3 veg.	3 veg.	None	None
Turbidity — p.p.m.	4.	10.	0.	0.
Color — p.p.m.	32.	35.	6.	7.
Oxygen Consumed — p.p.m.	7.3	8.5	2.9	3.0
Nitrogen as free ammonia — p.p.m.	0.020	0.008	0.010	0.010
Nitrogen as albuminoid ammonia (Total) p.p.m.	0.214	0.242	0.094	0.100
Nitrogen as nitrites — p.p.m.	0.003	0.004	0.002	0.002
Nitrogen as nitrates — p.p.m.	0.10	0.12	0.02	0.02
Chlorides — p.p.m.	6.	6.	6.	6.
Alkalinity — p.p.m.	19.	2.	5.	16.
Hardness — p.p.m.	18.	22.	22.	22.
pH value	7.2	5.8	6.5	7.4
Iron — p.p.m.	0.20	0.20	0.00	0.00
Mineral residue (Total) — p.p.m.	28.	33.	25.	28.
Residue on evaporation (Total) — p.p.m.	49.	68.	58.	63.
Carbon dioxide — p.p.m.	3.	9.	4.	2.
Bacteria per c.c. on gelatine at 20° C.	23.	36.	1.	0.
Bacteria per c.c. on agar at 37.5° C.	4.	1.	0.	0.
Bacteria Coli, present (+) or absent (−) in stated number of c.c.	(+)10	(+)10	(−)50	(−)50
Presumptive test for Bacteria Coli present (+) or absent (−) in stated number of five 10-c.c. portions	(+)4	(+)1	(−)5	(−)5
Presumptive test for Bacteria Coli present (+) or absent (−) in 1.0 c.c.	(−)	(−)	(−)	(−)
Presumptive test for Bacteria Coli present (+) or absent (−) in 0.1 c.c.	(−)	(−)	(−)	(−)

greatly appreciated. The cost of chemicals for treatment has so far been less than estimated.

The mixing tank is so designed that it may be converted into a filter unit, and the plant which now has a capacity of 2.5 m.g.d. may be enlarged to one of 3.33 m.g.d. at relatively low cost whenever this construction is necessitated by increased consumption.

The results of an analysis of a set of samples collected on September 17, 1934, illustrate the performance of the filters (Table 6).

The contractors for the plant, excepting the pumping equipment, were Clark & Smith of Quincy, Mass., with A. C. Trojano and other local sub-contractors coöperating. The pumping equipment was furnished by F. A. Mazzur Co., Inc. of Boston. The plant is operated under the general direction of Superintendent John W. Mulcahey, with Chief Engineer Frank J. O'Rourke and assistants in direct charge of the purification plant. The works were built under the direction of Water Commissioners George A. Walker, Thomas E. Sears and Joseph Landers, with whose permission this description is given.

REFERENCES.

[1] Dixon. Eng. News Record 111, 317 (1933).
[2] Jordan. Water Works & Sewerage 81, 3 (1934).

STATUS OF CROSS-CONNECTION REGULATIONS.

BY C. W. MOWRY.*

[*Read September 20, 1934.*]

Since the Committee on Cross Connections of this Association presented its final report in December, 1928, (See this JOURNAL, March, 1929, p. 79), six states have enacted new cross-connection regulations or revised existing ones, so that the present status of state cross-connection regulations is as follows:

SUMMARY OF POLICIES OF STATE HEALTH AUTHORITIES.

1. States having regulations which prohibit cross-connections. (One of these states permits cross-connections protected with approved type double check-valves, with certain unapproved ground-water supplies)		12
2. States having regulations which require that all cross-connections be eliminated unless protected with approved type double check-valves and in two cases, chlorination in addition to the check-valves. (Four of these states prohibit *new* cross-connections)		11
3. States having no regulations regarding cross-connections but which have adopted the following policies:		
To prohibit cross-connections	5	
To study each case on its merits, eliminating cross-connections wherever possible and permitting certain cross-connections to remain if protected by double check-valves	15	
Unknown (Mostly Rocky Mountain States)	5	25
Total		48

The only New England state which has enacted new regulations during this period is Maine. In October, 1930, the Public Health Council approved the regulations of the State Department of Health, requiring that all cross-connections shall be eliminated and disconnected before July 1, 1931, unless protected by all-bronze double check-valves installed in a standard manner and inspected at least monthly. A private non-potable water supply may be used in connection with a public supply when the potable source is discharged into an open tank above the highest water level.

Policy of United States Public Health Service. The elimination and safeguarding of cross-connections was given considerable impetus by a letter dated January 11, 1930, issued by the Surgeon General of the United States Public Health Service to all state health officers. This letter instructs the state health officers, when certifying water supplies used for drinking

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and culinary purposes by inter-state carriers, to take into consideration the existence of cross-connections. The letter stated that full certification should not be given unless cross-connections with unapproved water supplies were either eliminated or equipped with modern protective devices, approved by the state department of health and installed and operated under the direct control of that department. The letter further stated that auxiliary intakes and by-passes were considered as cross-connections.

Enforcement of Regulations. In most states the local water and health authorities carry out the details of enforcing the state department regulations. The program of the East Bay Municipal Utility District, Oakland, Cal., for the elimination and control of cross-connections is an excellent example of a well organized campaign successfully completed with the coöperation of the California State Department of Health. The details of this campaign, which may be helpful to others faced with a similar problem, are as follows:

From time to time efforts had been made by the water company, with only indifferent success, to eliminate the large number of cross-connections which were known to exist. The management had been without proper authority to force eliminations. In December, 1928, shortly after the system became municipally owned, a regulation was issued to the effect that water service would not be furnished where cross-connections existed and that no new cross-connections would be permitted. About a year later the Surgeon General's letter of January 11, 1930, previously mentioned in this paper, was of particular concern, as the District furnished water to many inter-state carriers.

The State Department of Health in March, 1932, instructed the Water District to carry out the following plan by January 1, 1933:

1. Permit no new cross-connections.
2. Make a thorough survey for existing cross-connections.
3. Where private water systems involve the use of tanks, supply water over the top of such tanks.
4. When private water supplies do not involve the use of tanks, eliminate cross-connections entirely or protect them with approved double check-valves, tested every six months.

The survey showed 408 active cross-connections as follows:

Private wells for domestic use	224
Private wells for industrial use	80
Private wells for commercial use	88
Salt-water supplies	6
Swimming pools	10
Total	408

Property owners were then presented copies of the order from the State Department of Health including a plan of complying with the order, and a time was set for the completion of the work. Early in December 1932,

or approximately eight months after the orders were issued, the program was completed by the following method:

Public water service removed	51
Two supplies separated by independent systems of pipes	183
Public supply carried over top of tank	68
Well abandoned	18
Double check-valves installed in accordance with standard drawings prepared and approved by the State Department of Health	88
Total	408

The work, when completed, was inspected by a representative of the state, following which a full certification of the public water supply was given by the State Department of Health.

This experience again demonstrates that a great majority of cross-connections can be eliminated, provided water companies are given proper authority and support.

Conference of State Sanitary Engineers. In October, 1929, the Conference of State Sanitary Engineers adopted a report of its Committee on Cross-Connections which reiterated the recommendations of the 1926 Committee of the Conference, that all cross-connections should be abolished between safe drinking water supplies and other water supplies of a quality unapproved for human consumption. This report called particular attention to cross-connections between safe drinking water supplies and swimming pools and certain plumbing fixtures. The report also stated that cross-connections with sewers, around water purification plants, and through auxiliary intakes should not be permitted.

American Water Works Association. On May 2, 1932, Committee No. 8 of the American Water Works Association, under the chairmanship of our Past-President E. Sherman Chase, presented an exhaustive report on cross-connections at the Memphis convention. The Committee recognized that the ideal of perfection would be absolutely to prohibit cross-connections, but its recommendations were tempered from this extreme stand by its study of the actual accomplishments in the protection of public water supplies from the hazards of cross-connections. The report was approved by the Committee on Water Works Practice in 1933 and published in the Journal of the American Water Works Association, Volume 25, No. 3, March, 1933. The recommendations are as follows:—

1. (*a*) That no new cross-connections be permitted between safe and and unsafe water supplies, the quality of the respective supplies being determined by the state health authorities.

(*b*) That all existing cross-connections between safe and unsafe water supplies be eliminated, except that temporary cross-connections may be continued in use if made through properly installed and adequately supervised, all-bronze, rubber-seated double check-valves when such connections are approved by the state health authorities, and then only when

extraordinary circumstances prevent complete severance. At the discretion of these authorities, the additional safeguard of proper disinfecting equipment for the private supplies should be provided.

2. That deficiencies in the adequacy of public water systems be corrected in order to hasten the complete elimination of cross-connections.

3. (*a*) That by-passes around water purification plants and emergency intakes be eliminated in so far as practicable and as rapidly as possible.

(*b*) That when immediate elimination of such by-passes and intakes is not feasible in special cases, they should be adequately safeguarded in a manner approved by the state and local health authorities.

4. That opportunities for local pollution through improper plumbing installations and equipment be guarded against by a nationally uniform provision relating thereto in plumbing codes and that this Association coöperate with other agencies engaged in attempts to establish proper plumbing regulations.

Performance of Protective Devices.

No new devices have been developed for the protection of cross-connections since the New England Water Works Association Committee Report of December, 1928. There are now about 750 sets of all-bronze double check-valves in the United States and nearly 1000 sets of the iron-body type with working parts of bronze, in the United States and Canada.

Double Check Valves. It is important that double check-valve equipments be maintained clean and tight. The Connecticut State Department of Health has developed the following method of supervision of maintenance of these valves which has been very successful:

Check-valve installations are inspected three times a year by an engineer of the State Health Department. If a check valve does not test tight, it is immediately opened and corrected. Each year about October 1, a circular letter is sent to all owners of double check-valve installations, calling attention to the requirement for annual internal inspection and cleaning, and a return postcard is enclosed which the owner is required to fill in and mail after the valves have been tested and overhauled. Water-works officials also receive copies of the circular letter, and on occasions a special letter.

Such a special letter was sent to water-works officials in the fall of 1933, calling attention to an outbreak of sickness which had occurred in a mill in Connecticut, due to a cross-connection which had been installed for the purpose of supplying high water-pressure when needed. The State Department of Health pointed out that the regulations not only prohibit new cross-connections, but also place a certain measure of responsibility on water-works officials. The letter further suggested an annual check for the existence of unauthorized cross-connections.

Fire-Pump Chlorinators. The experience with automatic start-and-stop fire-pump chlorinators is confined to some 65 machines installed in 1928 and 1929 in New York State, to comply with sections of the State Sanitary

Code relating to cross-connections. The machine is an adaptation of the vacuum-type, solution-feed, manually-operated chlorinator commonly used in water works systems, and its performance over the 5½-year period has been satisfactory when properly maintained.

Interior Building Piping and Plumbing Fixtures.

Field experience with the enforcement of cross-connection regulations, and outbreaks of disease have both shown that public water supplies can be contaminated due to improperly designed or installed plumbing fixtures, hospital sterilizers, interior building piping, and cross-connections at swimming pools.

New York State Survey. The New York State Department of Health has recently made a state-wide survey of swimming pools. Cross-connections in building piping have been given considerable study, the results of which are contained in a bulletin entitled "The Elimination of Health Hazards Caused by Faulty Plumbing Installations and Fixtures."

Chicago Amebic Dysentery Outbreak. This paper would not be complete without referring to the outbreak of amebiasis which occurred in Chicago last year and which was attributed to faulty interior building piping. A detailed account of this occurrence will be found in a paper by Joel I. Connolly, Chief of Bureau of Public Health Engineering, Board of Health, Chicago, and Arthur E. Gorman, Engineer of Filtration, Bureau of Engineering, Chicago, presented at the 1934 American Water Works Association Convention in New York, N. Y.

The outbreak involved the guests and employees of two hotels and up to June, 1934, there had been discovered 850 cases of amebic dysentery accompanied by 52 deaths. After eliminating the food handlers of the hotels as responsible for the outbreak, a detailed study was made of the water and sewage systems of the hotels. Three important types of sanitary hazard were found. The first was an old piping arrangement which made it possible to siphon water from bath tubs and flush toilets into water lines. The second hazard was a sewer pipe suspended from the basement ceiling directly above a tank in which city water was cooled and piped to the upper floors. The sewer pipe was not tight and leakage from it could enter the water tank through a loosely-fitting and defective cover. The third hazard was a cross-connection between water and sewer lines.

As a result of this intensive investigation, the Chicago Board of Health adopted regulations on April 17, 1934, of which the following are the more important features: Cross-connections of any kind between the public water supply and any other water supply are prohibited. This is a restatement of the Board's previous policy. Wherever it is desired to use a public water supply in a piping system conveying any other supply of water, plans must be submitted to the Board of Health for approval. Where there is more than one piping system they shall be painted distinctive colors as

designated by the Board of Health. Whenever a water tank is emptied for purposes of repairs, cleaning, or for any other purpose, it shall be disinfected before being put back into service. Whenever any outbreak of illness characterized by symptoms of intestinal disease shall occur, it must be reported to the Board of Health by telephone and confirmed by letter so that measures for determining the extent and seriousness of the trouble may be employed.

Conclusions.

Cross-connection control is a never-ending task. Much has been accomplished; much remains to be done. Experience of many states and municipalities has shown that the vast majority of cross-connections are unnecessary and can be eliminated readily. For those relatively few cases where immediate elimination is impracticable the use of all-bronze rubber-seated double check-valves, regularly tested and cleaned, has thus far provided a reliable safeguard. The automatic chlorinator has also proved to be a valuable additional protective device where desired.

ACTIVITIES OF THE NEW ENGLAND REGIONAL PLANNING COMMISSION.

BY VICTOR M. CUTTER.*

[*Read September 18, 1934.*]

According to the jacket of a new book, Abraham Lincoln said, "If we could first know where we are and whither we are tending we could better judge what to do and how to do it." I suppose it is only in times of crisis that we are really interested in planning. The National Resources Board took the place of the old National Planning Board. The National Resources Board consists of the Cabinet members, three distinguished men who have known and been interested in planning for a great many years — Messrs. Delano, Merriam, and Mitchell and Charles W. Eliot, the Executive Director.

The Resources Board has divided the United States into eleven districts. New England, very properly, is District No. 1, and as far as planning goes we intend to keep it there. As a matter of fact, one of our states — New Hampshire — now leads all the states in actual results in planning. With the coöperation of the Governor, the Legislature, and State Development Commission, New Hampshire is doing a fine job in planning.

Our program is one which we believe will ensure the proper development of New England and the protection of its interests as a part of the whole national plan. The purpose is to secure the wisest and most economical use of public funds. It does not contemplate a search for new projects, but rather the development of the best plans for necessary current government expenditure and preparation for future emergencies. That is our official statement, but, as you all know, in the last two years more than two hundred million dollars have been spent during the existing emergency in New England. I think I do not need to argue with a group of engineers when I make the statement that if we had had some plan ready for such an emergency we might have received more for our money than we have under present circumstances. In other words, planning is nothing but budgeting for the future, the forecasting which every intelligent organization has been doing for years as a matter of course. When we give it the name of planning we make it sound more fearful and wonderful than it really is.

National Resources Board is one of the fifty alphabetical organizations, but I personally believe, and a great many others believe that it will be one of the agencies which will continue to exist. We are not spending much money. We have a very small office in Boston and are interested in regional planning. We are not interfering locally with water works, or on a state

*Chairman, New England Regional Planning Commission, Boston, Mass.

basis with other projects. But where two or more states are interested in one river, or a highway crosses state boundaries, we do hope to be able to help a little in coördinating activities and solving the problem involved, and also in tying the project into a national plan.

Our immediate objectives are as follows:

1. A 10-year program of public works, including parks, parkways, highways, and other developments.
2. A study of transportation facilities and suggestions for their coördination.
3. A report on the major existing and desirable land uses.
4. A report on suggested legislation.

Our specific plans are studies in connection with other planning agencies, and there are many of them. We have an advisory committee. We have sent out five or six hundred invitations and had four hundred responses in return. In other words, in New England there is a lively consciousness of the need for planning and for intelligent use of the public funds for necessary expenditures; not for new projects but for getting the most out of the money which must necessarily be spent.

We are interested particularly in the Connecticut River, the watershed, involving four of our states, its pollution, navigation, recreation — that is, fishing, swimming, and so on. We are also interested in the Merrimack River waterway in the same manner. We are interested in the development of motor arteries, in the creation of arteries of parkway design, in grade separation of intersections, the division of opposing traffic lanes, and the control of border land. We are interested in the New England shore line and in the preservation of areas suitable for public use. We want to bring all the states together, making our particular section of the country attractive. As you know, any one of our states at one end of the country can exert very little influence nationally, but six states together, with a little coördination — so that we can carry our proper weight — will merit the attention and get the results that we desire for the protection of New England.

We want to preserve the shore line and make sure that proper areas are set aside for public use forever. We have a regional plan, for instance, for the Fall River and New Bedford area. We are proposing to run a parkway from New York to Cape Cod, and it is of tremendous importance where that is to be located, whether it will pass through congested traffic centers or by-pass those and go where it should. In cases like that our engineers make suggestions to the local men who are in charge of the project. We cannot by any means determine the final location of such a parkway, but we can suggest certain things which might be overlooked by a man too close to the job, or by the local men who might want it to go in a particular place.

We want to coördinate the plans of all the agencies. For instance, in New Hampshire the foresters have done a great deal of planning. The Society for the Protection of Forests in New Hampshire has planned for twenty years the areas it wants, the mountain tops, the Old Man of the

Mountain, the Flume, and things of that kind. The splendid results which you have seen in traveling around New Hampshire are certainly justification for future planning.

Fish and game make one of our very important attractions in New England. Maine of course is well known, and New Brunswick is well known, but Vermont and New Hampshire are not well known for their fish and game. Very few people go there for hunting and fishing. We are interested in proper protection of natural resources of that kind. In this connection, this ASSOCIATION can help in preventing the pollution of streams, which we are of course interested in.

We have our railroad problems all over New England, and you all know how serious they are. We believe there must be some coördination between railroad transportation, bus, and air transportation. We are out to do all we can in helping them. Circulation, by highway, waterway, foot trail, and bridle path, interests us. It is not enough to prepare an interesting trail which ends at the state line; why not coördinate the plans of all the New England states? That is the thing we are interested in.

We are interested in the preservation of historic sites and scenic features, in recreation, in interstate reservations and parkways.

These are a few of our particular activities at the present time. We are trying to start at the bottom and work up. We are interested at the moment, and have done a lot of work on population trends. Of course where a water works, a highway, or any project of that kind is located, depends on what the population is and what it is going to be through a long period in the future. Water-works officials know very well what works had to be scrapped in putting in water works and can see what would happen if a little more thought had been given. The cost would have been a great deal less. We are definitely studying population trends. Thus far our work has been, of course, entirely in the form of research, and we are not yet ready to report to the public, because we believe it would be foolish for a planning board to go ahead and try to collect data or make plans before it has coördinated all available data that have already been collected, and put it in such shape that it can begin where others have left off. Hence it will be some time before we can present definite information.

We have made a study of our air ports and airways. Then we are studying the use of limited ways in relation to other highways. That is to avoid opposing lines of traffic, and so on.

We are also studying water use, which more particularly interests this ASSOCIATION. H. K. Barrows has been in charge of that work for all of New England. We are coöperating with him. He has gathered a vast amount of data and has probably been in touch with some members of this ASSOCIATION, in order to make his report just as complete and useful to the national government as possible. We are thoroughly aware of the importance of our water resources, not only for industry and power but for recreational uses, as I have already pointed out.

We are tremendously interested in the pollution of the Connecticut River and the Merrimack River. Governor Wilson of Vermont and Governor Winant of New Hampshire have been studying the Connecticut River situation and a great deal of work has been done in those two states. The association which we have in western Massachusetts has been very active, and Connecticut has done a good job, Hartford particularly, in planning the clearing up of that great river, which is one of the most spectacular in the world, from the recreational point of view, as well as useful in all the other ways that you know about.

I do not think that I need to urge upon a great body of engineers the necessity for planning, because your work, as I see it, is nothing but planning. Personally I have always felt, from my experience, that if we had done more planning, spent more time on our blueprints, taken more engineering advice in the past, we would have saved money. We would have increased our engineering expense but would have saved a great many million dollars. That thought sold me on the value of planning, and was the reason why I personally took hold of this work, and I hope it will become permanent.

While it may not be necessary for me to urge planning, there is some necessity to urge engineers to teach others the value of planning. In other words, engineers stick to facts and figures, and most of the engineers are doing a great job, but not much is known about that job. His Honor the Mayor of Boston has told you that he did not even know that there was a NEW ENGLAND WATER WORKS ASSOCIATION. I do not think you have done a good job in advertising your work. You have to tell the world in a definite way what you are doing. You have to educate the people, and must realize that people resist education.

Once I gave a lecture before a group of bankers, and I was going to point to the Latin-American loans. To sweeten the dose a little I told three stories, one at the beginning, one in the middle, and one at the end. The next day three or four men who had been there told me that those were great stories that I had told. I realized then that even bankers resist education. I don't know whether the case is so severe with engineers, but I do feel that engineers have not cashed in sufficiently on the great work they are doing.

I believe that, by and large, the water works have probably been better planned than almost any other of our public works. I doubt very much whether the New England Regional Planning Commission can help you, but I do know that you can help us, and we want the privilege of calling on this ASSOCIATION and its members for help when we need it, and if by any chance we can help, we are ready to do so.

THE WATER WORKS OF SAINT JOHN, NEW BRUNSWICK.

BY HON. R. W. WIGMORE.*

[*Read September 20, 1934.*]

Saint John, New Brunswick, the oldest incorporated city in the Dominion of Canada, occupies an enviable position with respect to its water supply. With a population of 65 000, the city has a fresh water supply sufficient to serve a city the size of Boston, Mass. Discovered by Samuel de Champlain on St. John's Day, June 24, 1604, Saint John was founded by United Empire Loyalists who landed there on May 18, 1783. Rich in history and surrounded by country of exceptional scenic beauty, Canada's eastern seaport has a water system which was established in 1834 and which now ranks among the finest on the North American Continent.

Two distinct sources supply Saint John with fresh water. These sources consist of two chains of lakes, situated in opposite directions, 12 miles apart. The river and harbor of Saint John separate the City into two parts, the east side being supplied by the Loch Lomond system, a series of five lakes, and the west side, supplied by the Spruce Lake system, a group of three lakes.

With a total area of 3 825 acres these eight lakes in 1933 supplied the city with an average of 20 375 846 gal. of water per day, which makes the exceptionally high per capita consumption of about 275 g.p.d. for the City of Saint John, allowing for industrial plant consumption.

From the establishment of the system until 1851 the supply was pumped into the city from the tail race of a grist mill on the outlet of Lily Lake (at the city's edge), the water having been conveyed from the mill to a steam pumping station by means of a wooden duct. This steam plant pumped water through a 10-in. cast-iron force-main to a reservoir of 300 000 gal. in the centre of the city. (This reservoir is now used as a garage and warehouse for the Water and Sewerage Department.) The reservoir was worked on the "intermittent plan," that is to say, the pump was operated each day until the reservoir was filled and supplied water by gravity until the following morning when another charge was delivered.

This system soon proving its insufficiency, a site for another reservoir, five miles distant from the city, was purchased in 1851. The land then secured contained an area of 135½ acres, besides a right of flowage on about 17 acres. Its cost was $1 860. This development resulted in the establishment of Little River Reservoir which gave the city a supply of about 80 m.g. of water, secured by damming a valley and causing the waters of Little River to expand to an extent of about 46½ acres. From the new reservoir a 12-in. main was laid to the city and some 500 000 gal. of water

*Commissioner of Water and Sewerage, Saint John, N. B.

delivered through it daily. The surplus water from the reservoir was used to operate a paper mill employing 30 persons and producing about 10 tons of paper per week.

Cholera, which developed to the extent of an epidemic in Saint John in 1854, stirred the inhabitants to a realization of the necessity of a "plentiful supply" of water. As a result an act of assembly was passed providing for the appointment of "The Commissioners of Sewerage & Water Supply for the City of Saint John (East) and part of the Parish of Portland." Similarly in 1854 a commission was appointed to construct and manage a water works system for West Saint John, then known as Carleton. This commission constructed six miles of 12-in. main from Spruce Lake to West Saint John, also four miles of distributing pipe from three to eight inches in diameter, 25 fire hydrants and 10 free hydrants, 10 stop gates and 50 service cocks. All the pipes laid in the West Side under this contract and many of those subsequently placed by the Commission were of sheet iron and cement and many lasted for more than 75 years.

At the inception of the east-side works, Portland was a parish adjoining the city to the northward. In 1871 it became a town and in 1882 a city, finally amalgamating with the City of Saint John in the year 1889. In that year all the water systems in the three districts were united and operated under a division of a newly created Department of Public Works, known as the Board of Management of the Department of Public Works.

Ten years later the Board of Management was abolished and a separate department constituted under the government of the "Water & Sewerage Board." This form of management continued until 1912 when the commission form of government was adopted in Saint John and I myself had the honor of being the first Commissioner of Water & Sewerage. This office I have held continuously ever since with the exception of a short period when I was in Ottawa as Minister of Customs in the Federal Government. The Commissioners are elected by the people every four years.

Returning to the consideration of the early works: — As in all early settlements the first members of the community obtained their supplies of drinking water from wells and their washing water from roofs. No house was considered complete without a hogshead or cistern to catch the rain water from the roof, and this was the case long after the piping of the city. Many houses had wells, generally in cellars, and to these pumps were attached for delivery of water upstairs. When we consider the proximity of pits for other purposes, it is easy to imagine how disease was spread and what a scourge cholera became when it entered.

These conditions proved the urgent need for a supply of clean water, safe to enter into food, and the water works referred to were established. In 1874 a second pipe was laid from Little River Reservoir and a pump placed on this line, deriving its power from Silver Falls. The water power at Silver Falls could only be relied upon for about 24 horse power, but this did away with about 170 house pumps and a corresponding amount of

blasphemy from summit residents who, besides paying the full water tax, had formerly been obliged to pump their water. In the same year a 24-in. main was laid from Spruce Lake to augment the West Side Supply and to be utilized for the operation of a pulp mill, now known as the Port Royal Pulp and Paper Mill which at present is using about 6 m.g.d. of water.

Demands from a steadily growing city, together with the necessity of supplying water to an increasing volume of ocean-going vessels, made it necessary to still further expand the system. In 1904, Mr. Frank A. Barbour, of the Boston firm of Snow and Barbour, (a Past-President of the NEW ENGLAND WATER WORKS ASSOCIATION) was retained by the Saint

FIG. 1.— ROBERTSON DAM.

This structure impounds Lake Robertson, the main source of Saint John's Water Supply. The stream formerly constituted the outlet of Loch Lomond.

John Common Council to make a survey and recommendations for enlarging the system. In due course Mr. Barbour recommended what became known as "The Loch Lomond Extension." His recommendations were approved and contracts were awarded in the following year for the construction of 10 300 ft. of 33-in. wood-stave pipe line and accessory structures at a cost of $48 930; 7 400 ft. of 39-in. reinforced concrete aqueduct, $40 710; 7 500 ft. of 48-in. reinforced concrete aqueduct (part in tunnel), $57 384; and a concrete masonry dam on the Mispec River with headworks and gatehouse, $36 640; total contracts, $183 664. The actual work cost much more, however.

This work took about four years to complete and gave the city greatly improved facilities which, with some improvements, are still in use. In 1929 we added 10 265 ft., or 1.95 miles, of 36-in. steel pipe, laid from Little River Reservoir to Phinney's Hill, at a cost of $170 000. In 1930 we laid 22 533 ft., or 4.27 miles, of 36-in. Lock Joint Reinforced Concrete Pipe from what is

known as the One Mile House to Little River Reservoir, at a cost of $350 432.91. Included in the cost was the construction of a road over the entire pipe line, enabling us to take trucks and cars over the line, through dense virgin forest, for inspections and repairs.

Another major addition to the system was the construction of 21 606 ft. or 4.09 miles of 36-in. Lock Joint Re-inforced Concrete Pipe from Manchester's Corner to Spruce Lake at a cost of $370 000. This installation, made in 1923, greatly increased the service to West Saint John. Further extensions in connection with the West Saint John supply are under contemplation with a view to providing an even greater supply for use in that district.

FIG. 2.— DAM AND GATE HOUSE AT SPRUCE LAKE.

In 1930 through construction of a concrete dam, replacing an old earthen structure at Spruce Lake, we affected a saving of approximately 1 000 000 g.p.d. of water which formerly was lost through seepage through the old dam. The new dam cost $42 000. Another forward step was the retaining of Frank A. McInnis, former engineer of the Boston Public Works Department, in 1916 and 1917, to survey the entire water system and recommend replacements. All renewals made since that date have been those planned under Mr. McInnis' able direction and provision has been made in his recommendations for renewals for many years to come.

In striking contrast to the "toy" system which marked the establishment of the Saint John water system in 1834, the city now owns and operates a system valued on December 31, 1933, at $4 309 404.81. It embraces 154.15 miles of water pipes and 50.79 miles of sewer pipes, 584 fire hydrants and 1 888 main gate valves. Of the total consumption of 7 437 184 000 gal. in 1933, industrial and commercial plants, supplied by meter, used 1 923-966 700 gal. With 420 meters in service, the receipts from meter bills last

year totaled $59 642.00 while the income from the water assessment amounted to $207 479.53. The department's total receipts for 1933 were $275 387.76. Expenditures for the year came to $274 590.13. Since the department came under the direction of the Commissioner of Water & Sewerage in 1912 it has shown yearly surpluses totaling $850 000 which have been turned over to the city and applied for the reduction of the general tax rate.

In Saint John the water assessment is separate and distinct from the general assessment, and it is a matter of departmental pride that the Water & Sewerage Department is the only civic department which has consistently paid its way year after year.

In July of this year we changed our system of meter billing from quarterly to monthly and instituted a discount of five per cent. on all current rate (1 cent per 100 gal.) bills paid within 10 days of issue. The results have been most gratifying, collections have improved remarkably and consumers now have a monthly check on the quantity of water used. They appreciate the better service, and we are glad to get in the money quicker, thereby reducing our bank charges and generally helping out with financial problems.

Meter rates in Saint John range from one half cent per hundred gallons to 2½ cents per hundred, industrial and manufacturing plants getting their water supply at the ½ cent rate, and the average commercial house, hotel, etc., paying one cent. All meters are charged on a monthly rental basis, equalling 10 per cent. of the cost of the meters per year. The meter rent charges range from 15 cents to $5 per month.

Private dwelling houses in Saint John are not metered but are assessed annually. The water assessment is made up as follows: A 0.25 per cent. of the valuation, plus a charge of $4 for every family residing in a house, $4 for each toilet, $3 per bath and 50 cents per wash basin. Where property is built on leasehold land the lease is capitalized at 6 per cent. and added to the value of the building for valuation purposes. Stores and other businesses carrying stock are also charged 0.25 per cent. on the stock.

Fire hydrants are constructed, and maintained out of water maintenance account at the expense of the Water & Sewerage Department, no charge being made to the Fire Department for use or maintenance of fire hydrants. Further service is rendered the Fire Department by the Water and Sewerage Department through a daily inspection of all hydrants during the winter, to guard against frozen hydrants. In addition an employee of the Water Department attends every fire in order to ensure the maximum of service from fire hydrants.

In Saint John the standard depth for water mains and service pipes is six feet, to protect against frost. Last winter, however, during abnormal winter conditions coupled with plowed streets for the convenience of motor traffic, the frost went to a depth greater than six feet in many instances and considerable trouble was experienced as a result. Particularly in connection

with fire hydrants was frost trouble encountered, and along with daily inspections of hydrants we found it necessary to frequently flush the leads from the mains to the fire hydrants. With an average pressure of 80 lb. per sq. in. (pressure ranges from 40 to 115 lb. per sq. in.) prevailing throughout the city, the fire hydrants supply sufficient pressure to fight all ordinary fires without pumping equipment, and only in extra large conflagrations or on the higher levels, does the Fire Department find it necessary to utilize pumping apparatus.

Unemployment is, of course, a major problem in Saint John at present as it is everywhere, and last year the Water and Sewerage Department provided work for 800 jobless men on sewer renewals. In this connection we developed the construction of reinforced concrete pipe which we were able to produce at less than half the price of manufactured concrete pipe at the same time utilizing local labor and locally-purchasing materials.

SANITARY SCORING OF SURFACE WATER SUPPLIES.

BY A. D. WESTON.*

[*Read November 15, 1934.*]

The development and use of a system of scoring to measure public health hazards is by no means new. For a number of years scoring systems have been employed in connection with the numerical rating of dairies, and the approval of shellfish to be harvested or sold is dependent to a considerable extent upon their sanitary score. In addition, the standards adopted by the U. S. Public Health Service in judging water supplies used on common carriers are a form of scoring. As early as 1916, the U. S. Public Health Service made a study of the various public water supplies in this state and attempted to rate these supplies by the application of a scoring system.

Scoring of water supplies was considered by the NEW ENGLAND WATER WORKS ASSOCIATION in 1927 when a proposed method of scoring was presented to the Association by a committee consisting of E. Sherman Chase of Metcalf and Eddy, Engineers, Chairman, J. F. Jackson, then Chief Engineer of the Department of Public Health of Connecticut, and the writer. The Association adopted the report of this committee as "A Tentative Working System." The matter was presented to the American Public Health Association at its meeting in Montreal in 1931 and was referred to a committee appointed by the Engineering Section of that Association with instructions to work with similar committees of the Conference of State Sanitary Engineers and the American Water Works Association. Mr. Chase has been particularly active in this work with the view of having a system of scoring adopted and in 1932 had the temerity to present a paper on the subject to the American Water Works Association. In this paper, which is entitled "Numerical Rating of Public Water Supplies," he sets forth that among other things the primary object of any scoring system is to bring about an improvement in inferior water supplies and to maintain a high standard of quality in all water supplies. He emphasized that a scoring system furnished a means of providing a balance sheet whereby the sanitary assets and liabilities of any supply could be compared. It is in relation to this latter aspect that the writer desires to bring the subject before you at the present time.

In spite of the various activities of Mr. Chase and the Committee of this ASSOCIATION, so far as is known, no general use has been made of a scoring system as recommended. The reason for this, in the opinion of the writer, is that its proper application has never been thoroughly understood.

* Chief Engineer, Massachusetts Department of Public Health, Boston, Mass.

System of Scoring.

Mr. Chase's proposed system of scoring may be considered as divided into two parts: Part I dealing with surface-water supplies and Part II dealing with ground-water supplies. The reason for this division is obvious. Each of these groups or parts is in turn divided into three parts: a part relating to pollution hazards, a part relating to protective measures, and a part relating to the quality of the water supplied. To bring this before you more closely the following outline for surface-water supplies is presented.

Pollution Hazards. You will note that this outline is divided into two columns, that on the left being entitled — "In the Black" and that on the right "In the Red." I think we all understand the difference these days between being "In the Red" and being "In the Black." Part I of this outline relates to pollution hazards and the score offered for no hazard is 60. The first hazard indicated is that due to possible pollution from the population residing within the limits of the watershed, and to obtain a factor in this regard Mr. Chase has devised the following penalty formulae:

$$2\sqrt{p_1+0.7\ p_2+0.39\ p_3 \text{ etc.}}$$

Where pollution is indirect as from well-constructed cesspools or where the sewage is diverted off the watershed.

and

$$8\sqrt{p_1+0.7\ p_2+0.39\ p_3 \text{ etc.}}$$

Where direct pollution may take place.

The writer is not responsible for these formulae and as the scoring system is introduced to call attention to the pollution hazards, a discussion of the relative merits of these formulae would appear to be unnecessary. The symbol p_1 refers to the population per square mile residing in a zone not over 50 miles from the water works intake, p_2 to the population per square mile residing in an area 50 miles to 100 miles from the intake, and p_3 to the population residing from 100 to 150 miles from the intake, etc. In Massachusetts, outside of possibly the Lawrence and Boston Metropolitan water supplies only p_1 need be considered, as we have no watersheds having a population residing at a greater distance than 50 miles from the intake. The question might arise as to what danger there would be from pollution by population residing within a watershed where proper sewage disposal facilities are provided or where sewage is diverted out of the watershed, but it should be borne in mind that there is always a hazard from persons residing within a watershed, and in this connection your attention is called to epidemics such as those of Plymouth, Pa., in 1885, with 1 104 cases of typhoid fever and 114 deaths, and Butler, Pa., in 1903, with 1 270 cases and 56 deaths. The penalties are reduced according to the form of sewage treatment, viz.: where sedimentation is provided the penalty is to be divided by 1.5, where complete treatment without disinfection is provided

"IN THE BLACK."
(Credits)

Score for no hazard..... 6

Subtract sum of Penalties from Credit for no hazard of 60; record a

OR SURFACE WATER SUPPLIES.
Hazards.

"IN THE RED."
(Penalties.)

1. *Population on watershed in 50 mile zones of intake:	
a. Contributing indirect pollution or where sewage is diverted from drainage area: $-2\sqrt{p_1 + 0.7\,p_2 + 0.39\,p_4}$, etc.	
b. Contributing direct pollution (sewage): $-8\sqrt{p_1 + 0.7\,p_2 + 0.39\,p_3}$, etc.	
c. Contributing direct pollution but with sewage treated divide penalty (b) by following factors according to degree of treatment: 1. Sedimentation, 1.5. 2. Complete treatment without disinfection, 3. 3. Complete treatment with disinfecting, 4.	
2. †Highways and railroads (per linear mile per sq. mile of watershed)	1
3. †Lumbering, labor camps, hunting, etc.	
a. Lumbering, labor camps, etc.	2
b. Hunting, picnicking, etc.	1
4. †Animal pollution:	
a. Direct	2
b. Indirect	1
5. Industrial wastes	1 to 10
6. Leaky intake, suction main or gravity main from relatively unpolluted source passing through sewage-polluted water	25 to 50
7. Fishing, boating, ice-cutting, bathing, etc. on distribution or small-storage reservoirs:	
a. Fishing and boating	2 to 10
b. Ice-cutting:	
Ice house at reservoir	2
Ice house away from reservoirs	1
c. Bathing	5 to 25
8. Accessible distribution reservoirs:	
a. Open and unprotected	5
b. Open but protected by locked fence, etc.	2
9. Inadequate protection against polluted water leaking into pure-water reservoirs, e.g., double-storage tanks, one part for safe and other for unsafe water; leaky raw-water conduits passing through clear-water basins, etc.	5 to 25
10. Cross-connections with polluted supplies:	
a. Single or no check valve should not be tolerated	25 to 50
b. Double-check, Factory Mutual type, regularly inspected	5
c. Same as (b), plus fire-pump chlorinators	3
11. Dual water-supply systems, one from a safe source and the other, for emergency use, from a sewage-polluted source	10 to 50
12. Inadequate pressure and storage	10

redit if sum of penalties is less than 60, or as penalty if this sum exceeds 60.

* P. 1, p. 2, p. 3, etc. are the populations per sq. mile in successive 50-mile zones.
† Applied only when population is less than 100 per sq. mile.

the penalty is divided by 3, and where there is complete treatment with disinfection the penalty is divided by 4. Where the works are improperly operated no divisor is used. Additional hazard penalties are:

Highways and railroads	1
Lumbering, labor camps	2
Hunting and picnicking	1
Direct animal pollution	2
Indirect animal pollution	1

There should be no discussion as to the danger of a highway or railroad crossing a watershed. The results of bacterial examinations show conclusively that because of automobile parties seeking camping and picnic places near the highways pollution of the waterways has resulted. The same is true where railroads cross a watershed and in this connection there is on record a serious epidemic in Scranton, Pa., with 1 155 cases of typhoid and 111 deaths believed to have been caused by pollution of the public water supply by sewage from trains. Again there is ample evidence of the danger of pollution from lumbering operations, especially where labor camps are maintained on watersheds and such areas are used for hunting and picnicking. The Ithaca, N. Y., epidemic in 1903, with 1 350 cases of typhoid and 82 deaths, was believed to have been caused by laborers employed on the watershed. As for animal pollution, applied where population is less than 100 per square mile, it should be borne in mind that our bacterial pollution index relates to the presence of organisms of intestinal origin. Unfortunately it is impracticable in routine work, in the bacterial examinations of water for the presence of organisms of the Coli-Aerogenes group, to determine the difference between pollution from man and that from animals. Accordingly, if the watershed is used extensively for pasturage or for the disposal of barnyard drainage the water from such a shed must contain large numbers of organisms of the Coli-Aerogenes group and must be viewed with suspicion. Remove the animal pollution as well as the human pollution and all difficulty in this regard is overcome.

The next item refers to industrial wastes and provides for a penalty of 1 to 10. This wide variation is intended to cover the various kinds of industrial wastes and the extent of the pollution. For example, wastes entering a stream from a bleachery might not cause serious pollution, whereas the wastes from a tannery or similar works are grossly polluted and contain large numbers of bacteria. The Massachusetts Department of Public Health for many years has recognized the danger of pollution from industrial wastes, and the rules and regulations adopted by the Department under Chapter III of the General Laws provide that no such wastes are to be disposed of within a watershed of a public water supply except with such treatment as will meet with the approval of the Department.

Item (6) relates to leaky intakes, suction mains or gravity mains which may pass through an area of ground which is polluted by sewage. The danger from such conditions has been forcibly brought to our attention

by the Yorkshire typhoid epidemic in 1932 with 270 cases and 23 deaths, and the Salem, O., epidemic in 1920 with 7 000 cases of dysentery, 884 cases of typhoid and 27 deaths. Similar hazards exist in the case of gravity mains when the water is shut off and the pressure in the main is reduced.

In the matter of the penalties for hazards from improper storage and distribution of the supply a discussion might be carried on indefinitely. Fishing, boating, ice-cutting and bathing have long been considered hazards where such practices take place in or on public water supplies. It might also be said in this connection that bathing in sources of water supply is not permitted by General Laws in Massachusetts and that the practice of fishing, boating and ice-cutting in reservoirs and ponds used for water supply is forbidden except by permit from the water department.

The penalty relative to the accessibility to distribution reservoirs is one which probably has not, up to the present time, received proper consideration especially in view of the extensive use of the automobile and various recreational activities. Comparatively recently the hazard of pollution of this type was so great as to warrant more rigid supervision of certain distributing reservoirs and actually fencing of the area of land in close proximity to them.

Item (9) refers to a condition which is common in connection with water-treatment plants and where dependence is placed upon the tightness of a concrete wall or other structure to prevent the entrance of the polluted water into the filtered or treated water reservoir and when the contents of sewers or other polluted water channels may pass through or over a conduit in a manner which may result in pollution. So far as is known there are few such hazards in Massachusetts. The water purification plants in Massachusetts are chiefly to improve the appearance of the water or to remove certain objectionable matter such as microscopical organisms, carbon dioxide, iron and manganese rather than to remove pollution. The attention of the Massachusetts Department of Public Health has been called to hazardous conditions in connection with the flow of drinking-water supplies through gravity conduits which in one case resulted in a recommendation to chlorinate the water.

Item (10) relates to cross-connections, the penalty provided being (a) from 25 to 50 in the case of single or no check valve as the only means of protecting the drinking water supply; (b) 5 for Factory Mutual Type double check-valves and (c) 3 for double check-valves with fire-pump chlorinators. This item also is one which could provide material for a very lengthy discussion, but the writer feels that all those engaged in waterworks practice are convinced that definite hazards exist where cross-connections are in use. There is a question in some of our minds as to whether or not we are severe enough in our criticism of such setups, and most of us are convinced that cross-connections of other types, viz.: connections with sewers for flushing, connections with swimming pools and cross-connections inside buildings such as that in Byrd's Cement Mill at Ada,

Okla., resulting in 161 cases of typhoid and 12 deaths and at a Chicago hotel which recently resulted in a serious epidemic of amebic dysentery should be more seriously considered.

Item (11) deals with dual water-supply systems. There are in Massachusetts emergency sources of water supply, but where such supplies exist and the water is known to be of questionable quality the Department has recommended that all permanent connections with such supplies be eliminated. In cases where the supply is not a polluted source but subject to pollution, provision for chlorinating the water has been recommended and rules and regulations have been adopted as in the case of the other sources of supply.

Some question might be raised as to why under Item (12) inadequate pressure and storage should receive a penalty of 10. I think it has already been pointed out that inadequate pressure might easily result in pollution entering the drinking-water supply. For this reason alone it is important that adequate pressure be maintained at all times in the distributing system. Inadequate pressure also results in reduced carrying capacity in the mains and may result in a shortage at times of drought and cause water-takers to obtain water from sources of questionable quality. The penalty in this case, while high, is not believed to be excessive.

Protective Measures. Part II of the outline relates to protective measures. These of course are a credit to the water department and are therefore listed "in the black," the total credit not to exceed 30 points. Inasmuch as they are more or less self-explanatory no considerable comment in their regard appears to be necessary. The credit of 4 points for proper sanitary regulation and enforcement might seem low, but it should be borne in mind that sanitary regulations are valuable only insofar as they are enforced. The same is true in the matter of patrol. Ownership of the watershed provides additional protection as in such cases "no trespassing" signs may be posted and all persons trespassing can be prosecuted, while violations of rules and regulations are often difficult to prove. The credit given under storage, Item (3), of course depends upon the actual length of storage. You will remember the experiments of Sir Alexander Houston, which have been borne out by others, that storage is a very valuable factor, but storage means just that and does not mean that credit should be given for storage when there is danger of short-circuiting or where there is possibility of pollution after the water has received the benefit of storage. Credit given under water purification depends as can be seen on the type and extent of purification. The total credits under water purification, including chlorination, filtration with or without coagulation, copper sulphate treatment, etc., are not to exceed 30 except that excess credits may go to offset penalties under protective measures and a maximum credit of 40 may be allowed for double chlorination and double filtration. There is some question in the writer's mind as to the proper application of the credits under this heading, as it should be borne in mind that many

communities must take their water supplies from streams polluted by sewage. In any scoring system, such municipalities necessarily start off handicapped because of the condition of the source of supply, and the only alternative is to provide suitable treatment works. Such supplies should be compared in a separate group and not with the unpolluted supplies common to this part of the country. Some criticism might be made of the credit allowed for treatment of the water for the removal of algae and other microscopical organisms and for taste and odor control. It is of course important that all water supplies be palatable as well as safe for drinking. Unless palatable the water consumers will seek other sources, possibly of questionable quality. It is plain to all of us that it is necessary to supply a water not only free from bacteria and safe for drinking but also a supply which is of excellent quality for all domestic purposes.

Penalties for failure to provide adequate protective measures are liabilities and appear "in the red." For lax enforcement of sanitary regulations there is a penalty of 2 to 4 depending upon the enforcement provided. Short circuits in storage reservoirs carry a penalty of 10. It already has been pointed out that if polluted water enters the intake without being properly purified by storage all other storage may be of little value. In this regard your attention is called to the Kingsville, Ont., epidemic in 1929 where there were 50 cases of typhoid fever and 10 deaths; and the Cochrane, Ont., epidemic of 1923 with 953 cases and 84 deaths.

In the matter of the operation of purification plants a penalty has been provided of 10 for inadequate dosage of chlorine, 5 for absence of duplicate equipment, making a total penalty of 15 in the matter of improper and inadequate chlorination. It has been the experience of the Massachusetts Department of Public Health that chlorinators often receive little or inadequate supervision. It is common to find chlorinators without any chlorine, other cases where an insufficient amount of chlorine is used and others where the chlorinator is awaiting the replacement of parts. The penalty provided where no coagulant is employed with mechanical filters is 10 and 5 where chemicals are of poor quality or have been exhausted. This needs no explanation as you all know that mechanical filtration of water without chemicals cannot be expected to remove bacteria from the water or to be effective in the manner of operation for which the plant was designed. A penalty of 5 is given in cases where the filters are in poor condition and again of 5 where combustible buildings are used for housing essential equipment. These penalties are somewhat severe for Massachusetts as the only mechanical types of filters in use are primarily for the removal of color, odor and taste and other objectionable characteristics and not for the removal of bacteria. However, some penalty should be provided for failure of such works, especially if the scoring system is to be applied in other communities. In addition some penalty should be provided for the presence of filter by-passes.

OUTLINE OF SCORE SYSTE
II Protecti

"IN THE BLACK".
(Credits.)

1. Proper sanitary regulation, patrol and enforcement.....
2. Ownership of watershed, 100 per cent.....
   (For less than 100 per cent., pro-rate according to area owned).
3. Storage (minimum) (not to exceed 20)..... $2\sqrt{\text{time in weeks}}$
4. Water Purification:
   a. Chlorination..... 1
   b. Pressure mechanical filters:
      With coagulation basin..... 1
      Without coagulation basin.....
   c. Gravity mechanical filters..... 1
   d. Slow sand filters..... 1
   e. Copper sulphate treatment, aeration, ammoniation, etc. for algae and taste control.....

For combinations of these purification methods, add individual scores; total credited not to exceed 30, except that excess credits may go to offset penalties upon protective measures and a maximum credit of 35 may be allowed with double filtration and a maximum credit of 40 with double chlorination and double filtration.

(Total Credits not to exceed 30).

Subtract sum of penalties from sum of credits; record s

OUTLINE OF SCORE SYSTE
III Qualit
(Period covered nc

"IN THE BLACK."
(Credits.)

1. Turbidity*: Clear.....
   0 to 5 p.p.m.....
   Over 5 p.p.m.....
2. Color*: Colorless.....
   0 to 10 p.p.m.....
   Over 10 p.p.m.....
3. Odor*: None.....
4. Taste*: None.....
5. Hardness*: Under 50 p.p.m.....
   50 p.p.m. to 100 p.p.m.....
6. Corrosiveness*: None.....
7. Iron and manganese*: Less than 0.5 p.p.m.....
8. Total bacterial counts on agar at 37° C.—24 hour*:
   Less than 100 per cc.....
   Over 100 per cc.....
9. *B. coli* types†: Absent in 100 per cent. of 10 cc. inoculations..... 2
   (Present in part of 10 cc. inoculations, pro-rate according to per cent. of samples positive.)
   (Total credits not to exceed 30.)

Subtract sum of penalties from sum of credits; record a

Add the results of the subtractions made under I, II and III and record the sur

* Sum of credits for these qualities not to exceed 10.
† Weekly analyses for unfiltered supplies, daily analyses for filtered supplies.

OR SURFACE WATER SUPPLIES (Continued).

Measures.

"IN THE RED."
(Penalties.)

1. Lax enforcement of sanitary regulations, improper or inadequate regulations, irregular patrol or none	2 to 4
2. Short circuits in storage reservoirs	10
3. Improper operation of purification plants (not to exceed credit for plant):	
a. Inadequate dosage of chlorine	10
b. Intermittent operation of chlorination apparatus, absence of duplicate equipment, etc.	5
c. No coagulant with mechanical filters	10
d. Exhaustion of chemicals or chemicals of poor quality	5
e. Filters in poor condition	5
f. Combustible buildings housing essential equipment	5
4. No or inadequate laboratory control of water quality:	
a. Untreated supply	5
b. Treated supply	15
5. Incompetent or untrained filter operators	15
6. Politicial interference	15

redit if result is positive and as penalty if result is negative.

OR PUBLIC WATER SUPPLIES (Continued).

onditions.

exceed one year.)

"IN THE RED."
(Penalties.)

1. Odor: Penalty for bad odors depending on character and intensity up to	5
2. Taste: Penalty for bad taste depending on character and intensity up to	5
3. Iron and manganese: Penalty for excess of 1 p.p.m.	3

redit if result is positive and as penalty if result is negative.

the Total Score. If the total score exceeds 100 credit units, record result as 100.

A penalty also is provided for inadequate laboratory control as follows: 5 in the case of untreated supplies and 15 in connection with the treated supplies. This item is one which should be given careful consideration by all water-department officials. It should be borne in mind that in a state like Massachusetts, where 238 of the 355 municipalities have public water supplies, it is impracticable with the appropriations available for the state authorities to make frequent bacterial examinations of samples of the water from the various supplies. Moreover, in the opinion of the writer, it was never intended by the Legislature that close supervision be maintained by the Commonwealth as in Chapter III of the General Laws, which outlines the duties of the Department of Public Health, it is stated that the Department shall have general oversight of inland waters. Most of the large municipalities in this state where water purification plants are in use have their own laboratories. Other municipalities should provide closer supervision over the bacterial condition of the water and where possible provide laboratory facilities.

Quality Conditions. Part III of the outline deals with quality conditions, the total credits not to exceed 30. The principal credit is given where bacteria of the Coli-Aerogenes group are absent. The necessity of having a penalty for objectionable odor or taste already has been discussed. The credit for a non-corrosive water, in the opinion of the writer, is inadequate and provisions should be made for a credit for corrective treatment. Corrosive waters usually result in turbid conditions in the distributing mains and objectionable water being supplied when the water at the source may be clear and colorless and of excellent quality except for its corrosiveness. In addition corrosive waters may result in lead poisoning. In the scoring system in the case of iron and manganese reference is of course made to the water at the source and not in the distributing system. It does not appear to be necessary to discuss the credits for the bacterial condition of the water, other than to state that the weight of 25 out of a possible 30 is too low rather than too high.

Application of Score System to Ten Surface-Water Supplies in Massachusetts.

This scoring system has been applied to some of the water supplies in Massachusetts after careful studies had been made by our Engineering Division of ten public surface water supplies and the results of our efforts in this regard are shown in four tables, viz: Table 1, dealing with pollution hazards; Table 2, protective measures; Table 3, quality conditions; and Table 4, a summary of the scores. In judging the scores it may be considered that —

75–100 is a good score
50– 75 is a fair score
25– 50 is a poor score
0– 25 is a bad score

Municipality "A" has a well organized water department with ample funds for carrying out its work. Its greatest difficulty is a penalty of 25 for cross connections. There is no excuse for single check-valve installations in any municipality, much less this. There is no laboratory control and for that reason the municipality is penalized 5 under protective measures, and because of the fact that the local population insist on maintaining bridle paths on the watershed and because a part of the watershed is a park reservation, conditions over which the water department has no control, a penalty of 3 is given. Again this municipality is penalized because of odor and taste of the water due to the presence of microscopical organisms.

Municipality "B" is one of our largest municipalities, in which the water is treated for the removal of color and microscopical organisms. This municipality also is penalized because of cross-connections and for population on the watershed. The elimination of cross-connections would give this municipality a very high score.

The third municipality indicated as "C" also is penalized because of the population on the watershed and until recent years was penalized for cross-connections. Other penalties can be removed by preventing hunting and picnicking and by chlorination of the water. If these conditions are remedied, the score will be materially increased.

Municipality "D" also is one of our large cities and here, as in the case of "C", the score can be considerably increased by the elimination of cross-connections and treatment of the supply.

The fifth municipality indicated as "E" is one with which the Department of Public Health has had considerable difficulty for a number of years. As a result of our activities the water is now being chlorinated, bids have been advertised for the construction of filters and the elimination of cross-connections is contemplated. The carrying out of these plans will improve the score of this municipality considerably. Similar improvements are being made in connection with municipalities "F", "G", and "I". In the case of municipality "H" the water supply has long caused the Department of Public Health considerable concern, and the Department has recommended that a new source of water supply or filtration works be provided at the earliest practicable date. Supply "J" is naturally of good quality and safe for drinking, and it would be difficult to remove the population from the watershed except by purchase of land at considerable cost, but there is no reason why the municipality should not improve conditions by the removal of cross-connections and posting the watershed. The writer has not attempted to score any of the ground-water sources in Massachusetts as the hazards in connection with these sources are not great.

Mr. Chase in his paper published in the *Journal of the American Water Works Association*, Vol. 24, No. 9, discusses certain objections which have been raised to a scoring system. It is realized that the values assigned are purely arbitrary and have little scientific basis, but it must be realized that the values selected are based upon experiences with a great many water

TABLE 1.— SCORES OF 10 MASSACHUSETTS SURFA

"IN THE BLACK."
(Credits)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	
No Pollution Hazards.....	60	60	60	60	60	60	60	60	60	6
Total Credits.....	60	60	60	60	60	60	60	60	60	6
	A	B	C	D	E	F	G	H	I	
Net Score.....	29	8	33	0	8	22	44	39	4	1

ATER SUPPLIES FOR POLLUTION HAZARDS.

"IN THE RED."
(Penalties.)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	J
Population on Watershed	—	7	15	13	13	3	88	88	20	15
Highways and Railroads	2	1	2	2	2	2	3	3	1	1
a. Lumbering, labor camps, etc	—	2	—	—	—	—	—	—	—	—
b. Hunting, picnicking, etc	1	1	1	1	1	1	1	1	1	1
Animal Pollution:										
a. Direct	—	—	—	—	—	—	—	—	—	—
b. Indirect	—	1	1	1	1	1	1	1	1	1
Industrial Wastes	—	—	—	—	—	—	—	—	—	—
Leaky Intakes, Suction Mains, etc.	—	—	—	—	—	—	—	—	—	—
a. Fishing and Boating	—	—	—	—	—	—	—	—	2	—
b. Ice Cutting	—	—	—	—	—	1	1	1	1	—
c. Bathing	—	—	—	—	—	—	—	—	—	—
Accessible Distribution Reservoirs:										
a. Open and Unprotected	3	—	—	—	5	5	5	5	—	5
b. Open with locked fence, etc	—	—	3	3	—	—	—	—	—	—
Inadequate Protection Against Polluted Water Leaking into Pure Water Reservoir	—	—	—	—	—	—	—	—	—	—
Cross Connections:										
a. Single or no check valve	25	40	—	40	25	25	—	—	30	25
b. Double-check F. M. Type inspected	—	—	5	—	—	—	5	—	—	—
Dual Water Supply Systems — One from Safe Source and Emergency from Polluted Source	—	—	—	—	—	—	—	—	—	—
Inadequate Pressure and Storage	—	—	—	—	5	—	—	—	—	—
Total Penalties	31	52	27	60	52	38	104	99	56	48
	A	B	C	D	E	F	G	H	I	J

TABLE 2.— SCORES OF 10 MASSACHUSETTS SURFA

"IN THE BLACK."
(Credits.)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	
1. Proper Sanitary Regulation, Patrol and Enforcement	4	4	4	4	—	2	—	—	2	
2. Ownership of Watershed	3	2	2	1	—	—	—	—	—	
3. Storage	20	20	20	20	13	11	15	15	14	2
4. Water Purification:										
a. Chlorination	—	5	—	—	—	10	10	10	—	1
b. Pressure mechanical filters:										
with coagulation basin	—	—	—	—	—	—	—	—	—	
without coagulation basin	—	—	—	—	—	—	—	—	—	
c. Gravity mechanical filters	—	—	—	—	—	—	—	—	—	
d. Slow sand filters	—	15	—	—	—	8	—	—	—	
e. Copper sulphate treatment, aeration, ammoniation, etc.	3	—	—	—	—	—	—	—	—	
Total	30	46	26	25	13	31	25	25	16	3
Total Credits (Not to exceed 30)	30	30	26	25	13	30	25	25	16	3
	A	B	C	D	E	F	G	H	I	
Net Score	25	30	21	20	4	17	19	19	14	2

TABLE 3.— SCORES FOR 10 MASSACHUSETTS SURFA

"IN THE BLACK."
(Credits.)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	
1. Turbidity	1	2	1	1	1	1	1	1	1	
2. Color	1	—	—	—	—	—	—	—	—	
3. Odor	—	2	—	—	—	—	—	—	—	
4. Taste	—	2	—	—	—	—	—	—	—	
5. Hardness	2	2	2	2	2	2	2	2	2	
6. Corrosiveness	1	1	1	1	1	1	1	1	1	
7. Iron and Manganese	1	1	1	1	1	1	1	1	1	
8. Bacteria — 37°-24 hr.	5	5	5	5	5	5	5	5	5	
9. *B. Coli* types	20	20	19	20	12	20	20	20	20	2
Total	31	35	29	30	22	30	30	30	30	3
Total Credits (Not to exceed 30)	30	30	29	30	22	30	30	30	30	3
	A	B	C	D	E	F	G	H	I	
Net Score	28	30	27	28	20	26	26	26	28	2

WATER SUPPLIES FOR PROTECTIVE MEASURES.

"IN THE RED."
(Penalties.)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	J
1. Lax Enforcement of Sanitary Regulation, Improper or Inadequate Regulations, Irregular Patrol, or None	—	—	—	—	4	3	4	4	2	2
2. Short Circuits in Storage Reservoirs	—	—	—	—	—	—	—	—	—	—
3. Improper Operation of Purification plants	—	—	—	—	—	—	—	—	—	—
a. Inadequate dosage of chlorine	—	—	—	—	—	—	2	2	—	—
b. Intermittent operation of chlorination apparatus, absence of duplicate equipment, etc.	—	—	—	—	—	—	—	—	—	—
c. No coagulent with mechanical filters	—	—	—	—	—	—	—	—	—	—
d. Exhaustion of chemicals or chemicals of poor quality	—	—	—	—	—	—	—	—	—	—
e. Filters in poor condition	—	—	—	—	—	5	—	—	—	—
f. Combustible buildings housing essential equipment	—	—	—	—	—	—	—	—	—	—
4. No or Inadequate Laboratory Control of Water Quality	—	—	—	—	—	—	—	—	—	—
a. Untreated supply	5	—	5	5	—	—	—	—	—	—
b. Treated supply	—	—	—	—	—	—	—	—	—	—
5. Incompetent or Untrained Filter Operators	—	—	—	—	—	—	—	—	—	—
6. Political Interference	—	—	—	—	5	5	—	—	—	—
Total Penalties	5	0	5	5	9	13	6	6	2	2
	A	B	C	D	E	F	G	H	I	J

WATER SUPPLIES FOR QUALITY CONDITIONS.

"IN THE RED."
(Penalties.)

Factors.	MUNICIPALITIES.									
	A	B	C	D	E	F	G	H	I	J
1. Odor	1	—	1	1	1	2	2	2	1	1
2. Taste	1	—	1	1	1	2	2	2	1	1
Total Penalties	2	0	2	2	2	4	4	4	2	2
	A	B	C	D	E	F	G	H	I	J

TABLE 4.—SUMMARY OF SCORES FOR 10 MASSACHUSETTS SURFACE WATER SUPPLIES.

Factors.	MUNICIPALITIES.										Score not to Exceed.
	A	B	C	D	E	F	G	H	I	J	
I. Pollution Hazards	29	8	33	0	8	22	44	39	4	12	60
II. Protective Measures	25	30	21	20	4	17	19	19	14	28	30
III. Quality Conditions	28	30	27	28	20	26	26	26	28	28	30
Total Score	82	68	81	48	32	65	1	6	46	68	100

supplies. Other objections are that such a scoring system represents the individual viewpoint of the person making the score and that the system is difficult of application because of the very small amount of definite information available in most of the municipalities. Regarding this criticism Mr. Chase brings out very forcibly that the water department officials should have such information as is necessary for a scoring system if they are to protect and improve their supply properly. As to scoring being a tedious job and involving considerable time and effort for the average water-department superintendent, I doubt if this is so. It is my experience that water superintendents are vitally interested in their plants and desire to be advised of conditions which may affect them adversely. Hence I am sure that the amount of time spent by any water-works superintendent on the scoring of his water supply would not be found to involve any considerable amount of time or be considered time lost. In the writer's opinion, it is not advisable that a scoring system be adjusted to compare the water supply of one community with those far removed. The system as recommended by the NEW ENGLAND WATER WORKS ASSOCIATION and modified by Mr. Chase in his paper before the American Water Works Association applies particularly well to water supplies in New England, but it would be unfair to compare the New England scores with those of say the Ohio Valley without an adjustment in the score. Massachusetts has long enjoyed the reputation of having excellent water supplies. Let us keep up this reputation by budgeting each year with the idea of carrying out needed improvements. Let us remove all suspicion of a relation between the public water supply and communicable diseases.

Discussion.

Roger W. Esty.* How much of an undertaking is it to score a system?

Mr. Weston. I think the best thing for me to do is to refer that question to Mr. Knox, who made up all of these scores. How long did it take you on these ten, Mr. Knox?

Joseph C. Knox. About a day and a half.

Warren J. Scott.† I would like to ask if you think it is feasible to score on a comparable basis a supply with a large storage reservoir and a supply taking water from a running stream or a small storage reservoir.

Mr. Weston. In the case of the ten supplies scored, it worked out very well. One of the supplies on the list has very little storage; another supply has a very large amount of storage. There are so many factors that must be considered, other than storage, that I do not think such differences would bother the scorer a great deal.

Murray P. Horwood.‡ I want to thank the members of this Association for the invitation to discuss the paper presented by Mr. Weston. I can see little reason why Mr. Chase suggested that I do so, because there are so many others who are more qualified to speak authoritatively on this subject. There are, however, a few ideas that I have gleaned in other fields of public health endeavor which may have some application to this subject and which may be of interest to you.

In the first place, I think all scientifically minded men interested in any phase of public health work are constantly seeking for an objective evaluation of their activities, thus eliminating the subjective element in the appraisal of their work. One of the values of the scoring system is found in the fact that it eliminates, to a large extent, the subjective element in scientific appraisals.

The scoring system is also of value because it places the appraisal of the activity under consideration on a uniform as well as a scientific basis. The use of a scoring system also tends to elevate the standard of rating employed and to improve the qualifications of the individual conducting the appraisal, for unless the surveyor or inspector is qualified to make a scoring, he will not attempt to use a score card. The score card is, therefore, a stimulus to employ men of superior training and to use high standards in appraising municipal activities.

Furthermore, the use of a score card helps to stimulate popular interest in municipal activities. The score card is something which the lay person can understand. For a community to have a rating of 90 per cent. on its water supply instead of 80 per cent., for example, is something which the average individual can comprehend. In this way the score card serves to stimulate popular interest in one of the important aspects of community life.

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‡ Massachusetts Institute of Technology, Cambridge, Mass.

The score card is also valuable because it may serve as an educational force in the community, for as one examines a score card rating and observes the items in which a community is strong and those in which it is weak, it is obvious that the appraisal can be used as an educational influence to obtain the improvement necessary to bring the water supply of the community to the level of quality which it should enjoy.

The question of score cards is an old one, as Mr. Weston pointed out. Perhaps one of the earliest used in this country was the dairy score card developed by Dr. Woodward of Washington, D. C., in 1904. The scoring of dairies became very popular and the practice is now applied by health departments all over the country. It took into consideration two very important factors, that the quality of a milk supply is dependent first, on the methods used in obtaining and handling the milk, and second, on the equipment employed. It is the significance of the personal factor which I should like to emphasize particularly in considering the applicability of a scoring system to different types of municipal work. Score cards have also been used in the rating of pasteurizing plants, in scoring restaurants and food stores, in studying housing conditions, in studying municipal health activities, and in a variety of other ways.

Score cards are normally organized on a numerical basis. In this way, a subjective element is introduced which it is impossible to eliminate. Whether a certain item on a score card will receive 10 points out of 10, or only 5 points out of 10, depends on the individual making the rating. In order to eliminate this element, score cards have been developed on a Yes or No basis, instead of using a numerical rating. A question is asked: Does the individual or the community perform a specific service? and the answer must be either Yes or No. In this way the subjective element is eliminated almost entirely. In so far as this can be done, it is very desirable, but there is no question that the use of a percentage rating has distinct popular value.

The score card can also be used as a basis for competition. This has been done admirably, fairly, and successfully by the American Public Health Association with the coöperation of the United States Chamber of Commerce in its efforts to stimulate municipal public health activities throughout the country. In this campaign the city health appraisal form has been used. First adopted in 1929, it has been constantly improved through various revisions. The same thing would apply if a score card for the rating of public water supplies were adopted. The first score card employed for this purpose would have to be organized with an idea to existing conditions in order that most city supplies of good quality might achieve a satisfactory rating. Gradually, however, as conditions improved, the standards employed in the score card could be made more exacting in order to stimulate all communities to better and greater achievement.

We are all deeply indebted to Mr. Chase for his painstaking effort in the development of a scientific and carefully planned score card for rating

municipal water supplies. I have examined it thoroughly and there is little that I can add to it. It is an unusually well conceived plan. My hope is that it will be tried more extensively than it has been up to the present time, partly as an instrument of education and partly as a means of stimulating further improvement of our public water supplies. Not only does it take into consideration the pollutional hazards to which the water is exposed and the use of accepted devices for the improvement of the supply, but it also considers such items as laboratory supervision and the expertness of the personnel employed for purposes of control and supervision. It also provides penalties for laxness and improper operation, for improper sanitary supervision, and for other human factors that may affect the quality of a supply. Furthermore, the score card deals not only with the bacterial and sanitary aspects of a water supply but also with its physical and chemical characteristics. In general, these items are covered pretty thoroughly.

There are just one or two items about which I might raise a question. I was interested to observe, for example, that a definite numerical value of 5 points is given to public water supplies which have a total count on nutrient agar at 37 deg. C. after 24 hours of less than 100 per cc. If the count is 101 or 102 the rating would be zero. This sharp decline from maximum to minimum scores seems perhaps unwarranted, and it might be desirable therefore to have definite bacterial zones with corresponding ratings, because after all the difference between 100 and 101 or 102 bacteria per cc. does not have any sanitary significance. At present, if a water supply is on one side of the line it receives full credit, but if it falls on the other side of the line it does not receive any credit at all.

It would also be desirable, I believe, to correlate the scores with the prevalence of sickness in a community, particularly the intestinal diseases like diarrhea, dysentery and typhoid fever. Certainly there ought to be a high degree of correlation between water supplies of excellent quality and absence of water-borne intestinal diseases. Where such a correlation does not exist, something must be wrong. Similarly poor water supplies should show a high degree of correlation with the prevalence of intestinal diseases. At any rate, such studies should be made in evaluating the quality of a municipal water supply.

Whether or not different score cards should be employed for water supplies in different parts of the country, is a debatable point. I am inclined to believe that it would be undesirable to have multiple score cards. We have been able to evolve one score card for rating municipal health activities. We use one score card for scoring dairies. We use one score card for rating the sanitary equipment of our school buildings. I believe we can also evolve one score card for rating public water supplies throughout the country, in spite of differences of origin, differences in quality and differences in treatment; because the one thing in which we are especially interested is the quality of the supply at the time it is delivered to the consumer.

If we stress this point, we should be able to devise a score card which will be of value not only in determining the sanitary quality of the waters in use throughout the country, but also to develop an instrument which will have great potential value as an educational force for the improvement of public water supplies in general.

One final word: In the rating of municipal public health activities by the American Public Health Association, it was found desirable not to have the individual health officer perform his own rating, although this was done for personal enlightenment in many instances, but to employ an impartial observer, who had special training and experience, and who was an outsider. This practice tends to eliminate the subjective elements in the use of the score card. Furthermore, since this practice permits the trained individual to view a situation with trained eyes and to interpret conditions with a trained mind, it enhances the intrinsic value of the scoring system. It is therefore conceivable that some day, perhaps through this Association or through the American Water Works Association, a few carefully selected individuals may be employed, men who are specially trained and qualified in the use of a score card for rating municipal water supplies, who will go from one community to another appraising each local supply, and who will then spend sufficient time with the local water superintendent or other responsible individual in the consideration of the defects observed. In this way, action may be stimulated to make the changes necessary to improve the quality and purity of the local water supply. Such action would be preventive in nature, a procedure far more desirable than the curative treatment we employ in most cases.

I am heartily in favor of using a suitable score card for rating municipal water supplies, and I think its potentiality for good is very great.

WARREN J. SCOTT. It seems to me in working out any system of scoring water supplies we must bear in mind that we have to deal with existing conditions, and it has seemed to me, in looking over the scoring system which Mr. Chase devised originally, that one cannot get very far without dividing up the types of supplies with which one has to deal. I personally do not see, for instance, how to compare the drinking water supply of Kansas City, Mo., with the drinking water supply of Hartford, Conn. They are two entirely dissimilar supplies, as you know.

I think that if a classification were made up on the basis, for example, of, first, supplies having their sources in polluted streams; secondly, perhaps, supplies deriving their water from the Great Lakes; third, supplies having a very large amount of storage and secured from relatively clean areas; fourth, supplies secured from relatively clean areas but having a small amount in storage; and fifth, ground water supplies,— then one might be in a position to compare the supplies in any particular group.

Of course it is said that we should not compare the supplies but that we should just consider each individual community; however, I think the use of any scoring system is bound to result in some comparisons, and I

believe we should compare supplies that are more or less in the same groups.

E. SHERMAN CHASE.* About eighteen years ago a sanitary scoring system was first applied to water supplies by Mr. Theodore Horton, then chief engineer of the New York State Department of Public Health, and myself; and the results were given in a paper presented before the American Public Health Association in 1916. Since that time I have given much thought and study to this matter, and I am convinced that some such score system as the one just outlined by Mr. Weston is feasible.

Mr. Weston referred to the sanitary engineer of the state of Kentucky objecting to a score system on the grounds that certain municipalities in Kentucky, for instance, have to take water from the Ohio River, which is grossly polluted along its course, and that it would be unfair to penalize such supplies since no better sources are available. To me this objection seems invalid. The man who dies of typhoid fever because the polluted source of supply is the only one available is just as dead as the man who is infected by a water supply whose source could have been bettered.

With the score system still in the experimental stage, the primary objective of papers and committee reports which have been presented to date is to get reactions to and criticisms of the system as it now stands. It is hoped that such papers will stimulate a wide application of the score system, so that it may ultimately represent the crystallized group judgment of people conversant with the sanitary quality of water supplies.

The advantage of a score system over a bacterial examination alone is that a score system which lists all possible ways in which a supply may become polluted, and possibly infected, takes into account the potential quality of the supply as well as its existing quality. It is important that *possibilities* of contamination must be recognized as well as *past* and *existing* contamination. Bacterial examinations are good so far as they go, but since they are based only on past performance, they do not go far enough. While it may be possible to predict from the past, one cannot be certain when judging a supply only from a few, or even a large number, of bacterial examinations that all the potentialities have been taken into account. In many municipalities serious typhoid fever epidemics have been averted more by the grace of God than by the inherently excellent quality of the supply or by its freedom from sanitary defects.

The score system is important, therefore, as a means of bringing to the attention of local authorities the hazards which threaten their supplies and the ways in which improvements may be made so as to eliminate, in so far as humanly possible, potentialities of evil.

*Of Metcalf and Eddy, Boston, Mass.

PROCEEDINGS.

NOVEMBER, 1934, MEETING.

HOTEL STATLER, BOSTON, MASS.

Thursday, November, 15, 1934.

President Howard M. King in the Chair.

Secretary Gifford announced the election of: Fred F. Parker, Hanover, N. H., Jesse P. Carpenter, Southwest Harbor, Me.; D. William Harford, South Norwalk, Conn.; Earl Ellsworth Mooney, Lynn, Mass.; George Crouse Houser, Brookline, Mass.

ARTHUR C. KING.* In connection with the revising of the ordinances in Taunton, the question of what should be covered by the ordinances and what should be covered by statute was brought up by the city solicitor, and following his suggestion the Water Board requested me to present to this ASSOCIATION the idea of drawing up a general statute — this, of course, applies only to the Massachusetts members — to cover water works operation and management, perhaps similar to the statutes which control electric light plants. In other words, to separate the financial and accounting departments of the water systems from other departments more than is now done in some of the less fortunate municipalities. From conversation with a number of the members this morning I believe that some are already pretty well supplied with their own statute, pretty well protected; but there are others who are still rather weak in their statutes.

If it is the feeling of the Massachusetts members of this ASSOCIATION as a whole, I should like to suggest, and make it a motion, in order to bring the matter up for discussion, that the Chair appoint a committee of five Massachusetts members to look into the advisability of such a general statute, and to draw one up in conjunction with Mr. Waddell, as it would have to meet with his approval, of course, to be passed and be satisfactory.

[The motion is duly seconded and carried.]

William W. Brush, Editor of Water Works Engineering, gave a talk on "Observations on Water Supply and other Subjects Made During a Tour of the British Empire." Arthur D. Weston, Chief Engineer of Massachusetts Department of Public Health, read a paper "Sanitary Scoring of Public Water Supplies." Roger W. Esty, Warren J. Scott, Murray P. Horwood, and E. Sherman Chase took part in the discussion.

Donald W. Foster, Superintendent of Water Department, Wilmington, Mass., described and showed moving pictures of construction work at Wilmington.

[*Adjourned.*]

*Superintendent, Taunton, Mass.

DECEMBER, 1934, MEETING.

HOTEL STATLER, BOSTON, MASS.

Thursday, December 30, 1934.

President Howard M. King in the Chair.

Secretary Gifford announced the election by the Executive Committee of the following new members: J. H. Read, Asst. Supt., Manchester, N. H.; Fred E. Ellis, Supt., Melrose, Mass.; Ernest J. Sullivan, Mass. Dept. of Health, Swampscott, Mass.; Gordon Campbell, N. E. Water & Elec. Service Corp., Worcester, Mass.; Maurice A. Libby, Acting Supt., Bath, Me.; Laroy G. Harris, Metropolitan District Water Supply, Enfield, Mass.; C. Roger Pearson of Whitman & Howard, Norwood, Mass.; *Associate*, Walter W. Field & Son, Inc., Cambridge, Mass.

The PRESIDENT. The proposed amendment of Section 2, Article VIII, is to be voted upon at this time:

"In addition to the annual convention, business meetings shall be held in Boston in the months of November, December, January, February, and March, the day to be fixed by the Executive Committee.

"By vote of the Executive Committee, and after due notice thereof shall have been given the members, additional business meetings may be held in or outside of Boston; but at least one meeting each year shall be held in northern New England and one in southern New England."

What is your pleasure?

FRANK J. GIFFORD. I move that it be adopted.

[The motion is duly seconded and unanimously carried.]

Irving E. Moultrop, chief engineer of the Edison Electric Illuminating Company of Boston, gave a short talk on the relations between the New England engineering societies and the NEW ENGLAND WATER WORKS ASSOCIATION.

A paper on Newburyport's new filtration plant was read by Paul F. Howard, Sanitary Engineer, of Whitman & Howard, Boston, Mass.

A paper on "Roadside Water Supplies," was read by Elmer W. Campbell, Director, Division of Sanitary Engineering, State of Maine Bureau of Health, Augusta, Me.

Lantern slides of Water Works Construction at Hartford, Conn., were shown by Harold W. Griswold, Deputy Chief Engineer, Water Bureau, Metropolitan District of Hartford County, Conn.

[*Adjourned.*]

PROGRESS REPORT OF THE COMMITTEE ON PIPE LINE FRICTION COEFFICIENTS.

On November 8, 1933, the Executive Committee of this Association authorized the formation of a Committee to report upon the question of pipe-line friction coefficients.

This Committee has been engaged in the collection and correlation of pertinent data upon the subject, and desires to submit a Progress Report at this time, in order to bring the matter to the attention of the Association with the hope that it will result directly, or indirectly in further coöperation in placing with the Committee all available data on the subject.

The primary objective of the Final Report is to make available more definite and selective data than are now found, relative to the effect of age upon the reduction of pipe capacity.

In the early stages of development of water-works systems neither the economic importance of capacity loss due to age, nor the extremely wide limits to which capacity loss in some instances might develop, were as evident as at the present time. Opinions upon the matter current some 25 years ago are reflected in a paper in the journal of this Association, in which it was stated that the value of the Williams-Hazen Coefficient for *new* Cast Iron pipe was from *130 to 140*, and for Cast Iron Pipe *25 years more or less old, was C=100*. The same paper pointed out that the coefficient for old Cast Iron Pipe 35 years or more in age *might* be as low as C=90 or even C=80.

As compared with values of C=80 or 90, considered the low limit at that time, we are at the present time confronted in many districts throughout the country with coefficient values as low as 40, 30 and in some instances 20.

If variations in values of coefficients were confined to a narrow and debatable margin then the value of an attempt to segregate conditions in various water systems would be hardly worth while, due to the difficulties of correlating and interpreting such data.

It has been found, however, that *extreme* variations occur, and the following factors are indicative of the importance of consideration of the trend of coefficients with age:

a. Coefficient values in unlined pipe are found to vary all the way from 145 to as low as 20.

b. In one city it was found that distribution mains were reduced in capacity equivalent to a coefficient value as low as 55, after only 8 years' service, whereas with the trend adopted in Williams-Hazen tables this value would not be reached until after 64 years of service.

c. Based upon the average trend from test data received by the Committee to date, a coefficient value of 87 has been reached in 13 years, as compared with the 30-year period assumed for average conditions in the Williams-Hazen tables. In other words, a capacity loss of 33 per cent. has developed in 13 years instead of in 30 years.

An indication of the difficulties to be encountered at the present time in an attempt to adopt proper coefficient values suited to any specific case, is afforded by the very general and limited discussion of this matter in the Williams-Hazen tables which, without question, represents the most com-

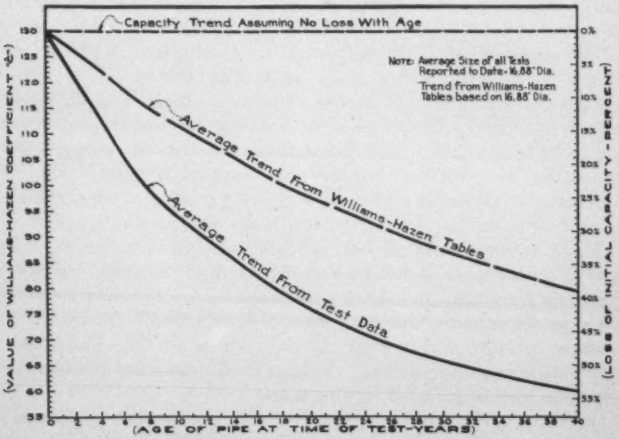
Capacity Trend Assuming No Loss With Age
Note: Average Size of all Tests Reported to Date= 16.88" Dia.
Trend from Williams-Hazen Tables based on 16.88" Dia.
Average Trend From Williams-Hazen Tables
Average Trend From Test Data
(VALUE OF WILLIAMS-HAZEN COEFFICIENT 'C')
(LOSS OF INITIAL CAPACITY - PERCENT)
(AGE OF PIPE AT TIME OF TEST-YEARS)

FIG. 1.— RELATION BETWEEN AGE AND W.-H. COEFFICIENTS.

As adopted in Williams-Hazen tables compared with Age-Coefficient Relation from test data submitted to date, September, 1934.

monly used book for computations of pipe capacities. It is well known that the column headings over the several values of C for which frictions are computed, show the age at which a pipe may be expected to depreciate to certain reduced values of C, based upon average conditions. In the text preceding these tables it is pointed out, however, that the figures represent the ages in years "at which it is *supposed* on an average, that Iron Pipe would reach the coefficients indicated." Furthermore "that these figures are intended to serve as a warning to the Estimator, of the reduced capacity to be faced with age and as a guide in making allowance for it."

In the same text it is pointed out that in one instance it has been found that with Lake Michigan water the deterioration actually found was equivalent to that indicated by the tables for a pipe only one-third of the

age of the pipe in question. Another instance is pointed out where representative tests produced results which corresponded fairly well with the figures adopted, and still another instance in which, to quote directly: "Tests of pipe up to thirty years old showed that the reduction in capacity was considerably more rapid than indicated."

Accordingly the object of the Report of this Committee is to present data which will afford an opportunity for the selection of trend curves, *which to some degree* may fit the specific case under consideration, rather than to depend, as has been the common practice to date, on the arbitrary use of C = 100, or in some instances on the headings in the Williams-Hazen tables which have been considered as representative of an average trend with age.

The scope which, in the opinion of the Committee, should be covered by the Final Report may be briefly outlined as follows:

First, to determine the actual trend of coefficients in unlined cast-iron pipe in a variety of systems and to show the actual trend curves in as many cases as possible, in order that data affording some opportunity for selection may be available. See the accompanying diagram.

Second, to determine what *factors in the quality* of supply have the greatest *bearing* on the *relative rate of capacity* reduction with age.

Third, to summarize all data available relative to coefficient values of pipe *with various types of lining*, as an indication of the proper values to use under these conditions.

Up to the present time data have been received from approximately fifty municipalities, and in a substantial number of these cases the data submitted are extensive enough to permit the development of a trend curve based upon tests of pipes of varying ages.

Questionnaires have been sent out in such form as to provide a place for recording test methods, the age and physical facts and characteristics of the pipe line, the test results, and the quality of water responsible for whatever condition was revealed by the test.

Preliminary studies have been made to ascertain what factors relative to the quality of the supply are of the greatest importance in affecting the relative rate of capacity reduction with age.

It has been deemed essential to divide the problem into two general classifications, namely, results obtained from study of supply lines, and results obtained from investigation of distribution systems.

Tests upon *lined* pipe have been received from approximately nine sources, and the greater part of these data has been tabulated in order to summarize as much as possible of the available information tending to establish the value of coefficients which may be anticipated with pipe having various types of lining.

The Committee is of the opinion that mass data from a large number of sources having a reasonable degree of accuracy, were of more value to the particular purpose than the very limited amount of data which would be

available if consideration was confined to tests involving a high degree of precision and laboratory conditions.

The Committee desires to state at this time that the work being carried on necessarily cannot be claimed to be mathematically precise throughout. However, an endeavor is being made to segregate the more reliable data and to develop from the study thereof certain trends and relations which, although not mathematically precise, are believed to be of sufficient importance to the question of efficient and economic pipe line design, to warrant the serious consideration and coöperation of every member of this ASSOCIATION who is in a position to furnish data.

Respectfully submitted,

FRANK A. BARBOUR,
W. W. BRUSH,
LAURENCE C. HOUGH,
CHARLES W. SHERMAN,
ELSON T. KILLAM, *Chairman*.

September 1, 1934.

SOIL CORROSION REPORT.

BY H. W. CLARK.*

Six years ago the writer was appointed the representative of the NEW ENGLAND WATER WORKS ASSOCIATION concerning the tests of the Bureau of Standards, Washington, upon the action of soils on pipes buried in different materials, that is, soil corrosion.

Beginning in 1922 this Bureau had buried in many parts of the country, from Texas to Maine and from New Jersey to California, a large number of pieces of pipe to study year by year the effect of these soils upon such pipes; from time to time reports have been made by the Bureau on the condition of pipes buried in these various soils for different lengths of time; and from time to time, also, some general conclusions have been given in regard to the work. For instance, in 1930 and again early in this year (1934) reports were published giving data and certain conclusions. In Research Paper No. 329 (1930) of the Bureau, a paragraph is given as follows:—

During 1930 the National Bureau of Standards removed from seventy test locations, approximately 1,300 specimens of pipe materials and this paper reports the results of the examinations of these specimens. The extent of the corrosion is found to depend largely on the character of the soil. Rates of corrosion appear to vary somewhat from year to year but the general tendency is for the rate to decrease as the time of the exposure increases. The data do not indicate that there is one best pipe material regardless of soil conditions. The material which appears to be best in one soil may appear inferior in another soil.

It was also stated in this paragraph that "it is too early to state whether this will hold true at the close of long-time tests. Supplementary tests indicate, however, that at least a number of soils have characteristic corrosive properties which can be expected wherever those soils are found."

This report contains many tables showing the rates of loss of weight of eight-year-old specimens and stating the actual time pipes of Bessemer steel, wrought iron, pure open-hearth iron, open-hearth steel, copper-bearing steel, sand milled cast-iron and DeLavaud cast-iron have been buried. Chapters are also given concerning precision of measurements of loss and pit measurements.

The report states that comparisons of the data of the different years disclose the fact that the rates of corrosion differ from year to year and that part of these differences can be accounted for by temperature variations and weather conditions, soil and specimens. While there is a tendency for the rates to decrease, the most nearly representative variations are probably those representing the average performance of all the specimens removed.

*Associate, Whitman and Howard, Consulting Engineers, Boston, Mass.

A further statement is that a study of the data discloses instances in which some other causes must control rather than those mentioned.

In regard to all the results given in this 1930 report, the authors state that their figures justify a very considerable degree of confidence that the data are representative of conditions under investigation and that they know of very few sets of corrosion data representing so many determinations and none covering so wide a territory or in which individual determinations have been made with the same degree of precision.

A chapter is given in regard to data on miscellaneous ferrous materials. Among these are high-silicon cast-iron, in which it was noted that the rate of loss of weight by corrosion was insignificant and that, with the exception of one, none of the specimens of this material has shown definite evidence of pitting.

Finally, the report states that the data so far obtained do not indicate that any one of the commonly used pipe materials is superior to the other for general use underground. In some locations one material or another appears slightly superior, but the precision of the data is insufficient to justify a comparison of materials; and the report also states that the corrosiveness of the soil can never be precisely expressed because of the variations in the soil, differences in the method of backfilling the trenches, the depth of burial of the pipes and the variations in moisture and temperature from year to year. It is stated that several causes appear to be responsible for the corrosiveness of soils and that it is improbable that a single satisfactory method for determining soil corrosiveness can be developed.

In 1934, that is, early this year, Research Paper No. 638 was published. Again, in the beginning, the statement is made that consideration of the data, that is, of specimens removed in 1932, does not materially alter the conclusions reached earlier that the character of the soil controls the rate of corrosion of ferrous materials and that in the same soil all of the commonly used ferrous materials corrode at nearly the same rate. It was also stated that metallic protective coatings show signs of failure after eight years in several of the more corrosive soils and also that several non-ferrous metals and alloys, such as lead, zinc and copper, are more resistant to soil action than the ferrous materials commonly used. There are paragraphs in regard to the fact that underground corrosion is an electro-chemical process and that strains, impurities and segregation cause potential differences which influence the rate of corrosion.

The conclusions in this paper are as follows:—

The data presented in this report are for the more corrosive soils in the investigation and do not represent the average corrosiveness of all soils.

The data are in substantial agreement with those presented in earlier reports and support the conclusions already reached.

There are indications that the rate of corrosion decreases with time in most soils because of more stable trench conditions or the formation of

corrosion products. The rate of decrease in general diminishes with time, indicating that a fixed rate of corrosion may ultimately be reached.

On account of unavoidable variations in soils of the same type, in metals even of the same kind, and in methods of construction, exact rates of corrosion cannot be predicted, but approximate rates of corrosion can be given for specified metals and soil conditions.

Differences in the rate of penetration of different pipe-line materials by soil action in the same soil are much smaller than differences in the rate of penetration of the same material in different soils. The type of soil rather than the variety of ferrous material is usually the controlling factor with respect to corrosion. In certain soils, however, one type of material may corrode much more rapidly than some other material and for this reason the soil to which it is to be exposed should be considered in selecting material for a pipe line.

The maximum rate of corrosion on a pipe line may be greater than the rate given in this report for the same material and soil because of the greater exposed area and local adverse conditions. Lower rates of corrosion over the same period of exposure are not to be expected.

Additional correlations between rates of corrosion and soil types should make the soil survey maps and reports of the United States Department of Agriculture of great value in preliminary estimations of soil corrosivity in territories where new lines are to be laid.

Copper, and alloys high in copper, corrode less rapidly than most ferrous materials in the soils investigated.

A zinc coating weighing 1 ounce per square foot of exposed surface should extend the life of the coated material at least 6 years in very corrosive soils and much longer under more favorable conditions.

On the whole, however, it seems to your representative that while all the results obtained are of interest and value, yet the data so far given and the conclusions of these reports, are confirmative data and conclusions rather than new or unexpected.

J. WALDO SMITH.

JONAS WALDO SMITH, a long-time member and Past President of the New England Water Works Association, died of a sudden heart attack at his home in New York City on October 14, 1933. He had not been in the best of health for several months; yet, characteristically, at the moment of his death he was preparing to go to the golden wedding celebration of a life-time friend and associate of his early days at Holyoke in Massachusetts.

J. Waldo Smith, as he was known by his friends, was born at Lincoln, Massachusetts, on March 9, 1861. He was the youngest son of Francis and Abigail Prescott (Baker) Smith. On his father's side his ancestry goes back to John Smith, who came to Watertown, Mass., from England as a freeman in 1636. On his mother's side the line goes to John and Elizabeth Baker who came to America about 1720. From these roots he inherited those inherent qualities of intellect, of courage, of honesty and of sincerity which shaped his life and made of him not only a man among men but, in very fact, a leader and wise counsellor of them.

While still a boy, Waldo Smith helped on the construction of the water supply system of his home town and had charge of its pumping station as fireman, engineer and superintendent. He attended the public schools and at 19 entered Phillips Academy, where he graduated in the scientific course in 1881. Thereafter he went to Lawrence, Massachusetts, and was employed in the Engineering Department of the Essex Company. Here he came into contact with those masters of hydraulics — Mills, Boyden, Davis, Francis, Storrow, Herschel and Freeman — and was inspired to further study at the Massachusetts Institute of Technology, where he graduated in 1887. During his summer vacations he worked for the Holyoke Water Power Company and then, for three years after graduation, continued under the same aegis and under the influence of the men previously mentioned. These were the formative years of his life. From the living examples before him he learned the necessity for care and precision and the importance of research and experiment; but, even more significantly, he also came to understand that human relations ranked equally with those of technical achievement. So it was that the traits of his ancestry came to bloom in the environment of his younger days and out of them grew the man of scientific vision and human understanding.

In 1890, a great water development was being made in the rapidly growing district of northern New Jersey, and Clemens Herschel, who was in charge of these operations, called young Waldo Smith to his aid. So began his work with the East Jersey Water Company, and he saw to a conclusion the constructions for the supply of the cities of Newark and Jersey City and their environs. These included a network of steel mains and distribution pipes together with the impounding dams and reservoirs on the Wanaque

and Rockaway watersheds. Of particular mention was the Boonton dam on the Jersey City supply. This was the first large masonry dam — 3 150 feet long — built in all its parts of Portland Cement; it was the first dam in which thermocouples were used to measure internal temperatures and the water from this source was the first municipal supply to be purified by chlorination. Also, as the need for better water became urgent, the Little Falls, N. J., filtration plant was constructed. This plant was the model and forerunner of that great host of similar works which have since given to American municipalities the best and purest waters on the earth. The Little Falls plant was due to the inspiration, the logic and the insistence of Waldo Smith and to the technical help of William B. Fuller, Charles L. Parmalee and others, to all of whom he would give due credit were this writing his own.

On these important undertakings from 1890 to 1903 Smith developed the teachings he had learned and the character he had formed during his earlier days in New England. This was the period during which the man was shaped by contact with men of affairs, by the responsibilities of his position, by the importance of his work and by his constant study of the human heart. And, while he was thus developing, his fame was spreading far and near. "None named him but to praise."

In 1903 the water situation in the rapidly growing city of New York had become most difficult, and the metropolis, confronted with the gravest of problems, sought their solution by engaging Waldo Smith as Chief Engineer of the Aqueduct Commissioners. From the beginning he showed his quality by infusing new life into a situation which was approaching an impasse. In rapid succession he decided the questions which were delaying operations on the New Croton Dam, then the largest masonry dam in the world; he resolved the difficulties which surrounded the Jerone Park Reservoir and the Muscoot Dam and put the design for the Cross River Reservoir under way. Here, in a new environment and under public auspices totally different from the private enterprises with which he had been previously associated, he showed such high technical skill and administrative ability coupled with such indomitable energy that, through his keen grasp of the human factor in life, he was able to accomplish results and to have his decisions accepted and respected by all. Later, in 1905, when the City of New York needed a man to direct the destinies of its Catskill Water Supply System, the choice naturally fell to Waldo Smith, and he was designated as Chief Engineer of the greatest, the most costly and the most far-flung water supply undertaking which, up to that time, had been conceived.

Entering upon that great task he did so with energy and determination but with the future always in view. Around him he gathered a staff on which he could rely. The work, he knew, was far beyond the capacity of any individual, and his immediate staff was augmented by a group of consultants so that every detail would be made as nearly perfect as humanly

possible. Waldo Smith was always the first to credit his associates, as he fondly called his staff, with accomplishment, and so he would not approve this biography were their names not mentioned. As Deputy Chief Engineer there were, from time to time, Charles L. Harrison, Merritt H. Smith, Alfred D. Flinn and Thaddeus Merriman. As Department Engineers there were Carleton E. Davis, George G. Honness, Robert Ridgway, Ralph N. Wheeler, Frank E. Winsor, William W. Brush, Walter E. Spear and Charles M. Clark. The Senior Designing Engineer was Thomas H. Wiggin. The Consulting Engineers were John R. Freemen, Frederic P. Stearns, William H. Burr, Alfred Noble, Allen Hazen and George W. Fuller. There was also a group of Consulting Geologists, James F. Kemp, W. O. Crosby and and Charles P. Berkey, whose duty it was to advise as to the geological features of the terrain in which the structures were to be built and through which the tunnels would pass. Waldo Smith was first among the American engineers who felt and understood the close relationship between the scientific arts of geology and engineering.

The preliminary plans and estimates for the Catskill System were completed within two months after his appointment as Chief Engineer. Then followed a period of careful planning and subsurface investigations so that, as Mr. Smith said, "both we and the contractors may know all about the work before we begin." The first contract was let in the spring of 1907 and water was first delivered to the city from the Esopus development in 1915. The second part of the system, comprising the Schoharie development, was completed in 1926. In the meantime Mr. Smith in 1922 retired as Chief Engineer but continued as Consulting Engineer to his last day. His great love was the Catskill Water System and those who worked with him. He gave to it and to them all he had and was happy to see it to its conclusion. He always felt, however, that this system was not sufficient for a city as great as New York, that it provided too small a margin of safety and that the only way of putting the water supply of the city on a sound basis was to increase it by developing a new source. The best of the possible sources available was the Delaware, but, as the waters of this river were interstate as between New York, New Jersey and Pennsylvania, the line of approach presented difficulties of an unusual kind. It was Mr. Smith's opinion that there was no reason why the situation could not be fairly composed, because the other states, sooner or later, would need Delaware water and also because the plan of new York was fair, just and reasonable. Beginning in 1921, with the hearty coöperation of the Commissioners of the Board of Water Supply, of which Mr. George J. Gillespie was President, of Mayor John F. Hylan and of Governor Alfred E. Smith, the establishment of compact commissions in each of the three states was consummated. Mr. Smith was designated as Engineer to the New York Commission, and the three commissions early in 1923 unanimously agreed on a form of compact under which the waters of the Delaware might be used

by the three states. This form was approved by New York, but failed in the legislatures of the other states.

Nothing daunted, the attempt to reach a satisfactory conclusion was continued and, in January, 1925, the commissions once more unanimously agreed on a second form of compact, but history repeated itself and the outcome in the legislatures was the same as in 1923. In the meanwhile the situation was growing more acute and it seemed clear that a water shortage would be inevitable by 1935. The City then, James J. Walker being Mayor, in 1927 formally approved a plan for utilizing these Delaware waters. New Jersey thereupon sought to enjoin the proceeding through an original action in the Supreme Court of the United States, while Pennsylvania intervened *pro interesse suo*. The issues were finally joined in 1929. Hearings before a Special Master were held in 1930, and the decision of the Supreme Court was handed down in May, 1931. This decision vindicated both the judgment and the foresight of Mr. Smith and established a new doctrine of interstate waters. *Ex facto jures oritur.*

This biography cannot attempt to describe the Catskill System, which was part and parcel of Mr. Smith's very life. That has been done in many papers, but it is essential that a few of the important developments of technical progress which grew out of this work should be briefly stated for posterity to read. In the largest sense they were the work of Waldo Smith, because of the continual support, encouragement and recognition he always gave to his men. While he constantly urged them on to newer and better things, his marvelous insight enabled him to rule out the chaff and few indeed were the innovations he approved that were not successful.

First, should be mentioned the deep pressure tunnels and particularly that which passed 1 100 feet under the Hudson River. No tunnels of such size and operating under so great a head had previously been built. Equally noteworthy was the 20-mile City Distribution Tunnel, far below sea level, passing right under the city and delivering its water through shafts into the distribution mains.

Second, was the use in the Olive Bridge and Kensico dams of expansion joints with copper cutoffs, drainage wells and inspection galleries. No previous dam had these features.

Third, was the consolidation by grouting under pressure with Portland cement of the foundations of all the dams as well as the linings of all the shafts and tunnels. It may be said that the modern art of grouting was developed under the direction of Waldo Smith.

Fourth, the use of bronze for all important valves and operating parts in all of the dams and along the aqueduct. The pressure-reducing needle valves at Ashokan and the riser valves and their control mechanisms in the City Tunnel, all of these were new and novel and involved special developments of design and in the art of bronze manufacture.

Fifth, the compressed lead joints in the flexible jointed pipe under the Narrows from Brooklyn to Staten Island.

Sixth, the beginning of an intensive study looking toward a determination of the reasons for the deterioration of Portland cement concrete. This work is being continued.

Seventh, the adoption of Portland cement mortar as an interior lining for large diameter steel pipes, together with the correlative outer concrete support for holding the pipes to true form.

Many other items could be mentioned, but these must suffice. Mr. Smith was a man of natural research instinct and, because of his understanding of hydraulics and the behavior of flowing water, the details of the great system as a whole were always in the forefront of his mind.

Following his resignation as Chief Engineer in 1922, Mr. Smith, as already stated, continued as Consulting Engineer to the New York Board of Water Supply. He also served in the same capacity for the Metropolitan Water District of Boston on its new development of the Ware and Swift watersheds. Among others, he gave advice and counsel to the cities of Philadelphia, Providence, San Francisco, St. Louis, Havana, Hartford, Baltimore, Kansas City, Kingston and Vancouver, B. C. He was Consulting Engineer on the famous Moffat Tunnel in Colorado.

The John Fritz Medal of 1918 was conferred on Mr. Smith, and in 1925 he was the recipient of the Washington Award of the Western Society of Engineers. Columbia University conferred on him in 1918 its honorary degree of Doctor of Science and in that same year there came to him from Stevens Institute of Technology the honorary degree of Doctor of Engineering. Mr. Smith was long a member of the American Society of the Civil Engineers. He served as Vice President during 1913 and 1914 and, in 1928 was elected an Honorary Member. Mr. Smith was also a member of the American Society of Mechanical Engineers, Institution of Civil Engineers of Great Britain, American Institute of Consulting Engineers, American Water Works Association, Boston Society of Civil Engineers, Chamber of Commerce of the State of New York, Municipal Engineers of New York City and Franklin Institute. Among his clubs were the Century, Technology and Engineers, all of New York.

Such was the man, so did he accomplish, and so was he honored in life. These words are in record of his memory. He was a genius of skill and prophetic vision. His leadership was that of fearless honesty. He held his profession as a cause to be kept sacred and to be made the better. To this end he accomplished far more than falls to the lot of most. As his name is written high on the record of accomplishment so also is it inscribed at the top of the scroll of those who labored to promote not only the welfare of the engineer as an individual but also the ideals of his profession.

And withal, Waldo Smith was a man of exceeding gentleness. The modesty of greatness was his. He shunned publicity. As honors came to him he insisted that they were the due of his associates. He was kind and considerate always, but forceful and direct whenever occasion required. He loved the simple things of life. In his friends, his flowers, his pigeons

his dog and in music he found peace and inspiration and comfort. He was a man to emulate — "None knew him but to love him." A great man has gone from us and the writers of this biography feel the unworthiness of their effort. Waldo Smith, we salute you. Your name and your influence will live through the years both as history records them and as the legion of your friends tells them to its children. *Sic itur ad astra.*

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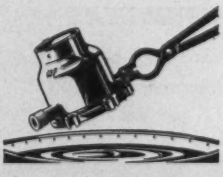

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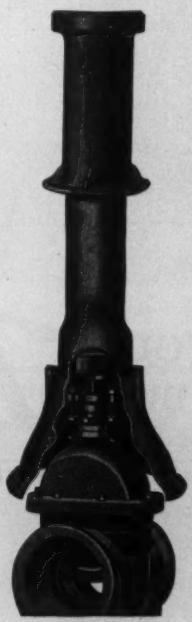

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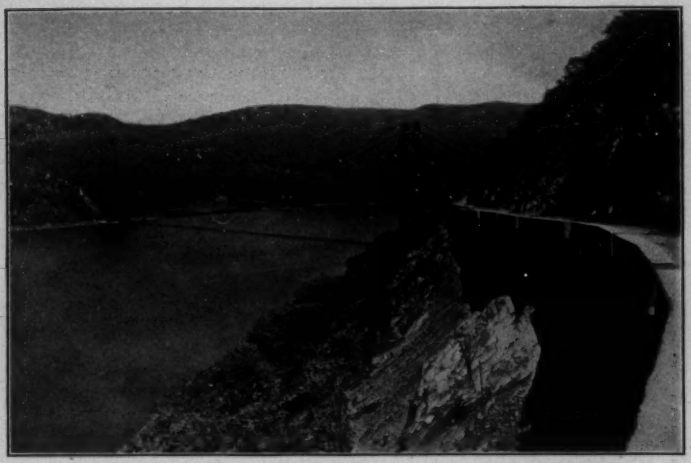

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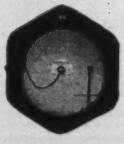

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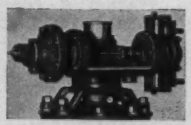

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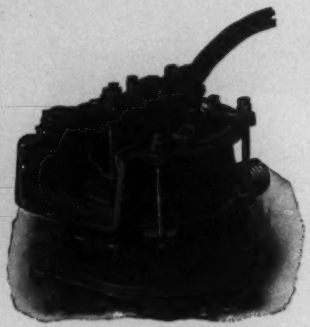

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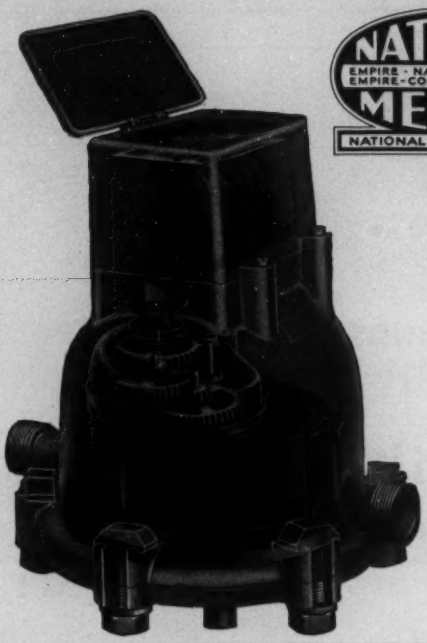

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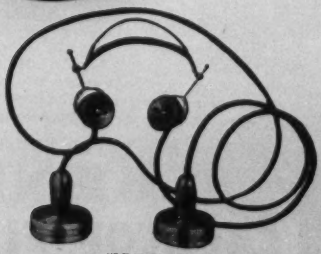

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Valves and Hydrants

Distinctive Features of the EDDY Valves

ONLY three parts are moved by the Stem—the ball and the two gates. Each gate is hung from one of the trunnions on the ball. A convex surface at the base of each trunnion fits a concave surface on the back of the gate. This allows the gates to adjust themselves properly to their seats. . . . The gates, being free to revolve on the trunnions, do not always seat in the same position. Gates are center bearing and adjustable. They are forced to their seats with equal pressure at all points. There are two hooks on the ball on sizes 4-inch and larger, which loosely engage with the gates.

Distinctive Features of Our New Swivel Top Hydrants

THIS new hydrant has all the advantages of the popular EDDY fire hydrant, plus several additional features. . . . Nozzles are in a short flanged section of the standpipe, which may be unbolted and turned to different positions. . . . Should the standpipe be broken, only the casting below the swivel head need be replaced. . . . To raise the hydrant to conform to a new grading, simply insert a flanged extension piece below the swivelhead. No digging. To add a steamer nozzle at any time, it is only necessary to replace the swivel head with one having a steamer nozzle.

Besides valves and hydrants to meet the most exacting demands of waterworks service, the complete EDDY Line includes: valves for sewage disposal works; valves for steam, gas and oil; check valves, foot valves, plug valves, shear gates, indicator posts, etc. EDDY valves are made in three classes: Iron Body Bronze Mounted, All Bronze, and All Iron Valves.

Eddy Valve Co.

WATERFORD NEW YORK

LEAD PIPE

Used by leading WATER WORKS for over 50 years. If proper weight is used, combined with good workmanship, your FINAL COST is assured, as REPAIRS are unnecessary. LEAD PIPE is sufficiently ductile to conform to any sagging condition. There is no RUSTING of pipe or joints; no DISCOLORATION of water.

LEAD WOOL

Every Atom Pure Lead

For calking pipe joints under the most difficult conditions; for overhead joints or in wet places where the use of molten lead is not only impracticable but dangerous — LEAD WOOL may be used to advantage.

It makes an absolutely tight joint which will withstand the highest pressure, yet be sufficiently elastic to allow considerable sagging or settling of the pipe, without danger of leaks.

Compared with the poured joint, in this respect, the superiority of LEAD WOOL is apparent.

LEAD PIPE TIN-LINED LEAD PIPE
PURE BLOCK TIN PIPE SOLDER
DUTCH BOY WHITE LEAD & RED LEAD

Highest Quality Soft Virgin Omaha Pig Lead

NATIONAL-BOSTON LEAD CO.

800 Albany St. Boston, Mass.

STANDARD SPECIFICATIONS

FOR CAST-IRON PIPE
FOR COLD WATER METERS

25c PER COPY

Write to

New England Water Works Association

PUMPS { CENTRIFUGAL, STEAM, TRIPLEX, ROTARY

POWER { DIESEL, GASOLINE, STEAM, ELECTRIC

PARDEE CHLORINATORS { DIRECT, SOLUTION, VACUUM

PORTABLE { LABOUR SELF-PRIMING PUMP, AIR COMPRESSORS AND TOOLS, *For Rent or Sale*

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PUMP & MACHINERY CO.
125 Purchase Street Boston, Mass.
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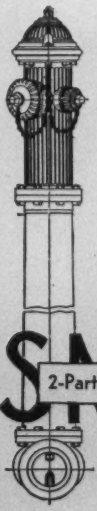


Minimum Trouble and Expense When Breaks Come

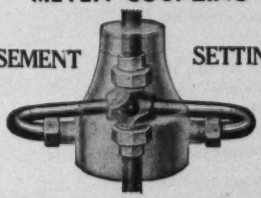
THE Smith Two-Part Standpipe Hydrant was designed to make the expense as small as possible when there is a break as the result, for instance, of careless auto truck driving.

The upper section will always break first. It can easily be renewed. And of course there can be no leakage of water because the main valve is of the compression type.

SMITH
2-Part Standpipe Hydrant

THE A. P. SMITH MFG. COMPANY
EAST ORANGE, N. J.

The
COPPERHORN
METER COUPLING
for BASEMENT SETTINGS



- ●1 Meter set horizontally at desired height in vertical pipe without ells, nipples or couplings.
- ●2 All copper water way. No rusting or corrosion. Freezing will not burst it.
- ●3 Smooth oversize tubing and sweeping bends, maximum flow.
- ●4 Meter changes do not disturb piping whether the meter is in or out.
- ●5 On new services it serves as a spacer to connect in the piping.
- ●6 Provides a permanent electrical ground connection.

May We Give You Further Information About the Copperhorn?

The FORD METER BOX COMPANY
Wabash, Indiana

Tap the Main and Follow Thru

with the

Hays Copper Service Method

The Hays method of joining copper pipe has made it the choice of hundreds of far-sighted water works officials. The Hays Copper Service Method covers every underground service requirement, it makes copper "talk" in any good pair of hands.

Once a Hays Connection is laid and buried it stays down, not for 5, 10 or 15 years, but for generations. $99\frac{9}{10}\%$ pure copper in heavy wall tubing and the patented Hays connection can take any punishment that settling soil, vibration, twist, or pull can give. It's a permanent method that puts service replacement costs on the toboggan.

If Water Depts. require Radius Seal Connections for Copper Service, Hays is equipped to take care of their needs.

Write for the complete story on the Hays Copper Service Method.

HAYS MFG. CO.

ERIE, PA.

Fig. 108E

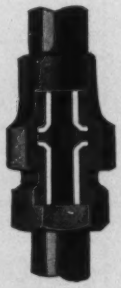


Fig. 120S

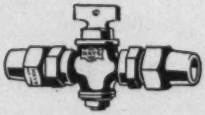


Fig. 54E

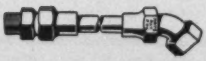
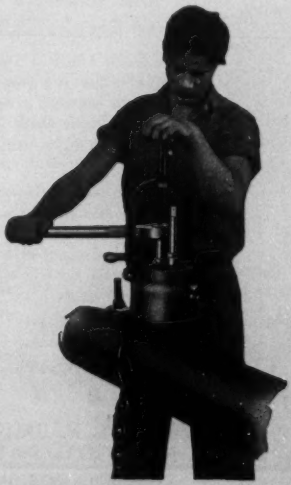


Fig. 119E

Fig. 125G



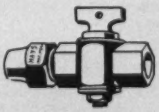
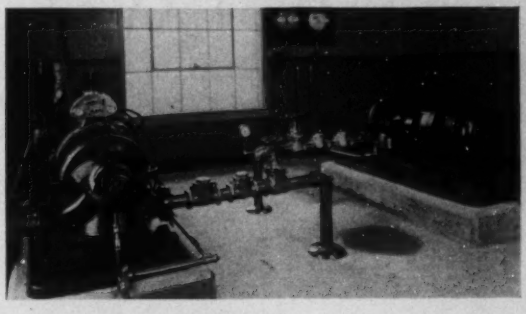


Fig. 82C

Fig. 121A

Fig. 79C



Two Fairbanks-Morse Fig. 5810 Pumps in Rochester, New Hampshire, Water Works

Investigate "5810"!

Wherever water service departments investigate — go into a thorough analysis of pump construction — "5810" wins! For this pump has a long list of exclusive features which are sure to appeal to the man who knows pumps.

So we say, "Investigate '5810'." A pump whose remarkable high hydraulic efficiency is obtained by a radical departure from conventional methods of pump design and manufacture.

An interesting bulletin giving detailed and illustrated description of F-M "5810" will be mailed on request. Write Fairbanks, Morse & Co., 178 Atlantic Ave., Boston, Mass.

Pioneer Designers and Manufacturers of POWER, PUMPING AND WEIGHING EQUIPMENT *104 Years*

FAIRBANKS-MORSE PUMPS

DE LAVAL

Centrifugal Pumps Lifting Water

from Infiltration Gallery and Pumping to Reservoir for Town Consumption and Fire Protection

GREAT BARRINGTON, MASS.
Green River Pumping Station, Great Barrington Fire District
Fay, Spofford & Thorndike, Consulting Engineers

The illustration shows one motor driven 500 g.p.m. single stage pump and one Gasolene engine driven 500 g.p.m. two stage pump. This installation also includes one motor driven 250 g.p.m. single stage pump not shown in the illustration. The two electrically operated units pump water into a low pressure distribution system, the gasolene engine unit serving as standby. The engine unit, however, is designed to pump into a high pressure distribution system at reduced capacity by increasing the speed of the engine.

Completely automatic vacuum priming system in this station will be illustrated in next issue.

TURBINE EQUIPMENT COMPANY

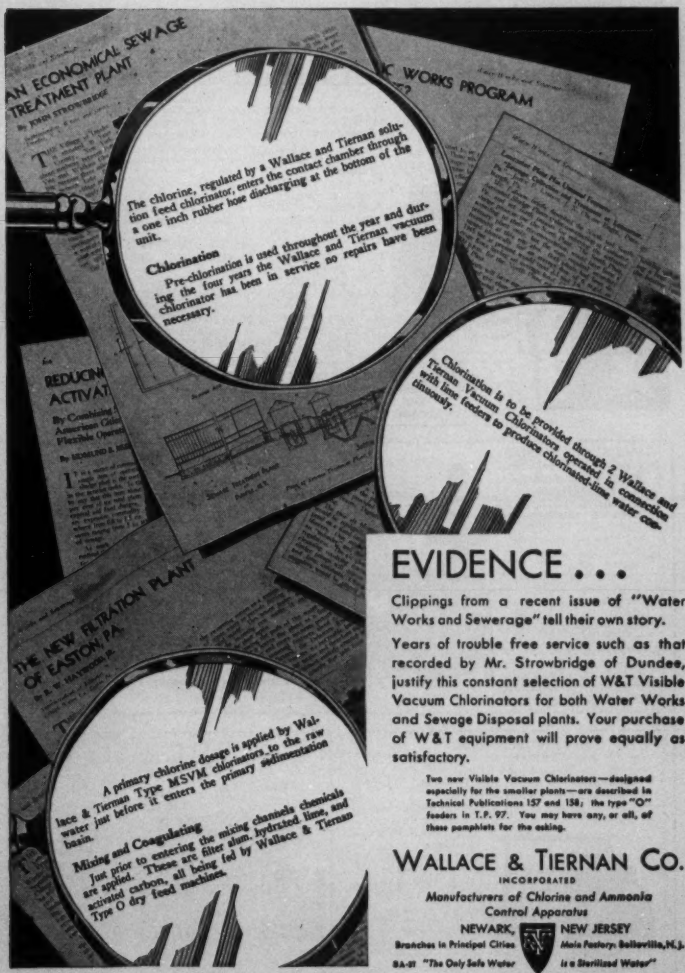
OF NEW ENGLAND

80 Federal Street Phone LIB erty 5993-4 Boston, Mass.

New England Representative for

DE LAVAL STEAM TURBINE COMPANY

TRENTON, N. J.


AN ECONOMICAL SEWAGE TREATMENT PLANT
By JOHN STROWBRIDGE
IC WORKS PROGRAM
The chlorine, regulated by a Wallace and Tiernan solution feed chlorinator, enters the contact chamber through a one inch rubber hose discharging at the bottom of the unit.
Chlorination
Pre-chlorination is used throughout the year and during the four years the Wallace and Tiernan vacuum chlorinator has been in service no repairs have been necessary.
Chlorination is to be provided through 2 Wallace and Tiernan Vacuum Chlorinators operated in connection with lime feeders to produce chlorinated-lime water continuously.
THE NEW FILTRATION PLANT OF EASTON, PA.
A primary chlorine dosage is applied by Wallace & Tiernan Type MSVM chlorinators to the raw water just before it enters the primary sedimentation basin.
Mixing and Coagulating
Just prior to entering the mixing channels chemicals are applied. These are filter alum, hydrated lime, and activated carbon, all being fed by Wallace & Tiernan Type O dry feed machines.

EVIDENCE . . .

Clippings from a recent issue of "Water Works and Sewerage" tell their own story.

Years of trouble free service such as that recorded by Mr. Strowbridge of Dundee, justify this constant selection of W&T Visible Vacuum Chlorinators for both Water Works and Sewage Disposal plants. Your purchase of W&T equipment will prove equally as satisfactory.

Two new Visible Vacuum Chlorinators—designed especially for the smaller plants—are described in Technical Publications 157 and 158; the type "O" feeders in T.P. 97. You may have any, or all, of these pamphlets for the asking.

WALLACE & TIERNAN CO.

INCORPORATED

Manufacturers of Chlorine and Ammonia Control Apparatus

NEWARK, NEW JERSEY

Branches in Principal Cities — Main Factory: Belleville, N.J.

BA-12 "The Only Safe Water Is a Sterilized Water"

GOLDEN-ANDERSON

Patent Automatic Cushioned Controlling Altitude Valves

We have enlightened many a water user in municipalities, in industrial plants and on railroads, as to the adaptability of these Golden-Anderson Valves, and as to their function of SAVING, and of eliminating troubles.

For automatically maintaining Uniform Stage of Water in Tank, Reservoir or Standpipes. Doing away with the annoyance of Freezing and Float Fixtures inside or outside of Tanks.

"Three Ways of Closing These Valves":
1st —Automatically, by water.
2nd—By Electricity, if desired.
3rd—By Hand

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe. No valves or fixtures inside or outside.

New Haven Water Co. New Haven, Conn. now using 2–24" 1–16" 2–12" 1–10" ALTITUDE VALVES

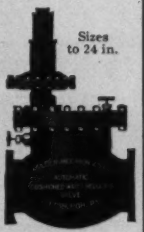
Remember!

"HOSTS OF REFERENCES"
Valves cushioned at all times by air and water
No water hammer or bursting mains

30 of these ALTITUDE VALVES sizes, 6" to 24" serving the City of Los Angeles, Calf., now.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required — No attention necessary.
5. Positively no hammering or sticking.



Sizes to 24 in.

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

They carry a constant water level in feed water heaters, Tanks and Reservoir by perfectly controlling the flow of makeup water.

Operated by protected enclosed copper float.

Cushioned by both air and water.

Operate without hammering, sticking or chattering. No metal-to-metal seats. Made angle or straightway.

Sizes 1 in. to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle — Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air.

Angle or Globe

Sizes to 24 in.

GOLDEN-ANDERSON
Patent Automatic Double Cushioned Check Valve

Sizes to 24 in. Angle or Globe

Automatically prevents reverse flow of pressure. Perfectly cushioned to prevent shock or hammer. Especially adapted for water works to prevent disastrous reverse flow of pressure due to pumps stopping. Arranged so that quick or slow operating may be obtained.

Golden-Anderson Valve Specialty Co., 1325 Fulton Bldg., Pittsburgh, Pa.

SPUN **BITUMASTIC** LINING

REG. U.S. PAT. OFF.

BITUMASTIC ENAMEL has been protecting water pipe lines for many years. Actual inspection has proven positive protection against highly tuberculating waters for over twenty years.

BITUMASTIC ENAMEL is now applied by the spinning method to the inside of pipe. This lining is about $\frac{1}{32}$-inch thick and exceptionally smooth. Improvements in BITUMASTIC ENAMEL now permit exposure to wide temperature ranges.

BITUMASTIC SPUN LINING insures a very high initial flow. More important — a high flow will be maintained for many years. Great economies are therefore possible in design. Deterioration of the inside of mains is eliminated. Pumps can operate efficiently for many years. Reduced operating costs result.

No taste, color or odor is imparted to the water.

BITUMASTIC SPUN LINING is an important contribution to water works practice. It is worth investigating as its use pays — and pays well.

Wailes Dove-Hermiston Corporation

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The "COREY" Hydrant

Why you should use GENUINE COREY HYDRANTS

Water to Nozzles quicker than other Hydrants.

Standpipe can be removed and replaced without shutting off water in main.

Ease of operation insured by knuckle joint principle.

Only 13 turns to completely open or completely close, but full flow with only 4 turns.

Nozzles screwed in — not leaded.

Can be lengthened without shutting off water.

Will not flood if broken.

Positive Drip — cannot freeze.

Standpipe can be revolved quarter turns — Nozzles always in right direction.

Ask for our Catalog "G"

CHARLES L. BROWN,
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RENSSELAER VALVE COMPANY
TROY, N. Y.

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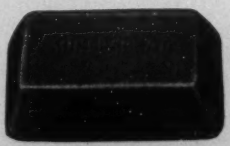
METER RATE SHEETS

For plotting average rates paid per annum by water consumers

Single sheet	$0.25
100 sheets, for thousands of gallons per annum	2.25
100 sheets, for hundreds of cubic feet per annum	2.50

New England Water Works Association



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MINERALEAD

For Jointing Bell and Spigot Water Mains

Easy handling, ingot form — Impervious to moisture — Absolute uniformity — Easy melting — Rapid pouring — No caulking — Less initial leakage — Bell holes unnecessary — A saving in cost of material and labor.

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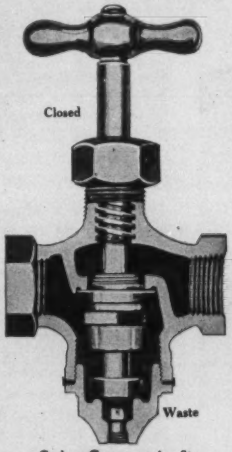

Gorham Compression Stop and Waste Cock

Copper Flanged Corporation Stop

S. & G. Water Works Brass Goods

S & D Heavy Pattern Slip Type Service Boxes

Byers' Wrought Iron Pipe

Annaconda Brass Pipe and Copper Service Tubing

Service, Roadway and Valve Boxes

Cast Iron Pipe and Fittings

SUMNER & DUNBAR

12-18 Pittsburgh St., Boston, Mass.

Telephone, LIBerty 1350

CEMENT LINED SERVICE PIPE

With Specially Adapted Lead-lined Fittings

Also Curb Cocks which eliminate Iron to Brass Corrosion both inside and out.

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LYNN, MASS.

PIERCE-PERRY CO.

Wholesalers of

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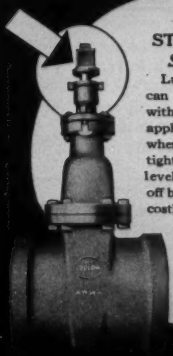
Byers Wrought Iron Pipe.
Youngstown Steel Pipe.
Valve and Service Boxes.

236 Congress St., Boston, Mass.

Telephone, Hancock 7817-7818.

Ludlow



NEW

STUFFING BOX

Saves Money

Ludlow gate valves can now be supplied with the Coster (patent applied for) stuffing box when required. You tighten it from the street level through the shut-off box, thus eliminating costly digging and repaving. Write for full details and prices.

The LUDLOW VALVE MFG. CO.
Troy, N. Y.

HYDRANTS HEAVE!

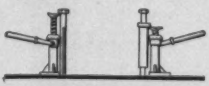
WATER DEPARTMENTS "CUSS." NEED MATHEWS

Water works men take their daily grief with remarkable calm and go right out to do something about it. But when hydrants go bad, they "cuss" —and they're entitled to. The right hydrant properly set should almost never fail.

Most troubles start when the wrong hydrant is bought. Because too many people think hydrants are just oversized spigots, we mention a recent accident to one of those fire-protective necessities. The moral, told ahead of time, is "buy carefully."

Here's a case from last winter's sub-zero spell in Hazleton, Pa. D. J. McGeehin, superintendent, reports "There was another peculiar case; a fire hydrant lateral was broken when a paved sidewalk in which it was set heaved, and pulled up the barrel of the hydrant with it." ('34 Jl. Pa. W.W. Assn.)

Mr. McGeehin's case is important and probably costly, but we don't think it's unusual. It happens often where heavy frosts, clayey ground, and unprotected hydrants exist. It shows why hydrants must be far more than just "spigots." Look:



If you put a heavy jack under the head of a cast iron bolt, and step down on it, you could snap it in two or pull it out. Frost does the same thing to hydrant barrels. But if you slip a sleeve around that bolt, you could jack away to your heart's content.

That's how a Mathews Hydrant works. Its barrel screws firmly into the elbow, but around that barrel is a loose iron case. When frost grabs, it grabs the protection case. When it heaves, it puts the hydrant under no strain. If you saved one digging and repaving job through having this Mathews protection case, you'd make a big saving.

But besides that, you always have your Mathews working parts available for inspection or repair, and if smashed by a truck, you can fix it instantly with no digging.

Install Mathews. Their cost is normal and you can practically forget upkeep. Besides which, you'll always be ready for fire, *and that's why you have hydrants.* Write for information.

MATHEWS HYDRANTS

and "SAND-SPUN" PIPE, a superior grade, centrifugally cast in sand moulds.

SOLD BY ESTABLISHED 1803 **R. D. WOOD CO.** 400 CHESTNUT ST. PHILADELPHIA

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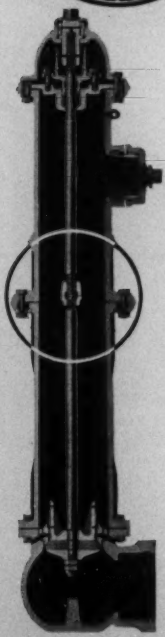


—a question that is Seldom Answered

It is a well established fact that truck and automobile drivers who, by accident, break hydrants, do not linger at the scene of their "crime." Of course there is an occasional exception. But in most cases they simply up and "beat it", leaving the city to foot the bill. A survey of such damage indicates the cost to the municipality is about $50 per hydrant.

But consider the difference in such a situation when an Improved Columbian Hydrant with the safety flange and coupling is the "victim." The Improved Columbian can "take it" and "come back." It is literally *the hydrant that pays for itself when hit.* Ten escapes by "hit and run" drivers who have knocked over Improved Columbian Hydrants leave no greater aggregate repair expense behind them than does one smashed hydrant of the conventional type.

You will quickly understand why we say "knocked over" in the one case and "smashed" in the other when you look at the illustration of the safety flange and coupling at the left. When the hydrant is struck hard enough to break a hydrant *not* having this feature, the safety flange breaks and the coupling, which is slotted, opens out, so that the stem is not buckled and the barrel not fractured. The hydrant merely yields to the impact instead of shattering. As a result, the expensive operating parts in the top are not damaged and the valve is not unseated to release and waste a flood of water.

To restore the Improved Columbian Hydrant to service after such breakage, you merely screw a new safety coupling onto the operating stem and attach a new safety flange to the hydrant barrel. In this way the damage that once cost $50.00 is reduced to $5.00 or less.

This feature coupled with the self-oiling top, longer lived main valve, and other low maintenance features of the Improved Columbian make it first choice of the man who buys fire hydrants on the sound basis of ultimate economy.

Write for Bulletin W-34 covering Columbian Fire Hydrants in detail.

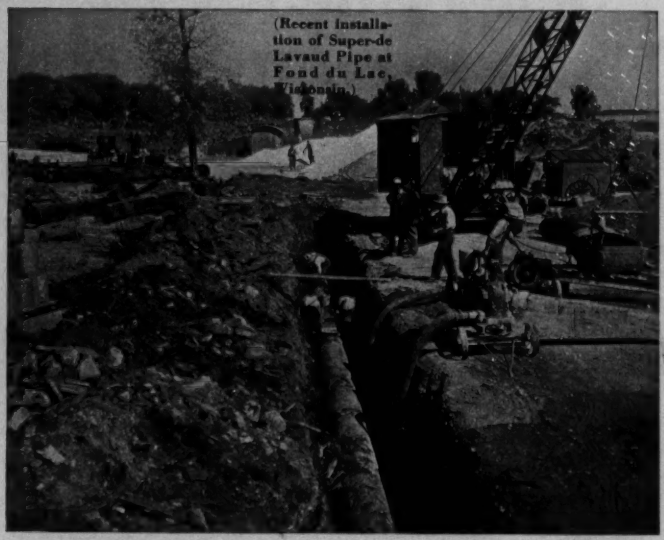
COLUMBIAN IRON WORKS

Chattanooga, Tenn. • *Division of Mueller Co.*

The Columbian 4-point contact Gate Valve has been still further improved. Read the interesting facts about these important improvements in Bulletin W-34.

Improved **COLUMBIAN**

FIRE HYDRANTS and GATE VALVES



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Users, who have bought and installed *more than seven million feet* of Super-de Lavaud Pipe, have found that it is virtually immune to those hazards.

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A unique, patented process in which the gray iron is centrifugally cast without chill in a metal mold gives Super-de Lavaud Pipe its extraordinary impact strength, toughness and ductility. Further facts about this process are contained in a booklet sent upon request.

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Foundries and Sales Offices throughout the United States

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